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NEW SERIES, VOLUME LXVI

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## Editorial

### PENICILLIN

THE chemotherapy of bacterial infections, which had been little more than an ideal until 1935, became a reality with the advent of prontosil. During the rapid development of sulfonamide treatment which followed, other organisms than *Streptococcus pyogenes* were found to be susceptible, and it seemed likely at one time that with the advent of new drugs of this type all bacterial infections could be brought under control. This hope has been disappointed, but another great therapeutic discovery has been made, which provides a remedy for some of the infections in which sulfonamides fail. That it will do certain things that sulfonamides will not is only part of its claim to our interest; it is a substance with hitherto unheard-of properties. It combines enormous anti-septic power with such a degree of freedom from toxicity to the mammalian body that one thousand times the concentration necessary for therapeutic action can be produced in the blood without ill effect. Such a combination of deadliness to bacteria with harmlessness to the body is more than the most sanguine chemotherapist can have pictured as possible before the properties of penicillin became known. Treatment with it is governed not by the fear of over-dosage, but only by anxiety to employ so

precious a remedy with the utmost possible economy.

Penicillin is now being produced on a considerable and rapidly increasing scale, in both England and the United States, by extraction from mass cultures of *Penicillium notatum*. No other method of production is yet known, although synthesis is an eventual possibility. In England not only the original employment of penicillin as a therapeutic agent but much of the subsequent study on which our present knowledge is based has been due to the enterprise of Dr. H. W. Florey and his colleagues.

Penicillin is an unstable acid, and the preparations used in therapeutics are its salts. The sodium salt employed for systemic treatment is hygroscopic and somewhat less stable than the more easily handled calcium salt, which is used mainly for local application. Potency is expressed in Florey (Oxford) units, an arbitrary amount determined by comparison with a standard preparation. Pure penicillin would have a potency of at least 1,000 units per mg. that in present use is far from pure, owing to the serious loss of active substance which further purification entails. Material with a potency of 100 units or less per mg. is quite satisfactory for clinical use. It has

been shown experimentally that untoward effects such as pain on intramuscular injection and fever or thrombophlebitis following intravenous administration are caused mainly by products of low potency. These effects are thus due to impurities rather than to penicillin itself.

In the presence of penicillin, even in very low concentration, certain species of bacteria not only cannot multiply but slowly die. Whether this effect is bactericidal or purely bacteriostatic is not clear; the distinction is not easily made and the mechanism of the effect is still unknown. More important, from a practical standpoint, is the fact that this effect is exerted in serum, blood, or even pus, as well as in a simple medium such as broth. Within wide limits it is also independent of the number of bacteria present. Yet even very high concentrations are without effect on the activity of leucocytes. Both by this form of study and by several others penicillin has been shown to have almost no local tissue toxicity. These facts explain the superiority of penicillin over sulfonamides for direct application to wounds. Concentrated sulfonamides are by no means altogether non-toxic; they are far from indifferent to bacterial numbers, acting best when only few are present, and they are inhibited by the breakdown products in pus. Penicillin overcomes all these difficulties, and the consequent difference in effect is fully equal to expectation.

It is essential to understand that penicillin exerts this action only on certain species of bacteria. It is indeed the most highly selective antiseptic known, and for years was used by Professor Fleming of St. Mary's Hospital, London, as an agent in selective culture media, which prevented the growth of some bacteria and permitted that of others. Most of the susceptible species are gram-positive; they include the three main pyogenic cocci (*Staphylococcus*, *Pneumococcus* and *Streptococcus pyogenes*), the gas gangrene group, anthracis, and diphtheria.

Penicillin can be used therapeutically

in two ways: It can be applied locally, or administered by parenteral injection so that it circulates in the blood and reaches every part of the body. The former method is economical but often difficult and sometimes inapplicable; the latter is sure in its effect but costly, requiring as a rule at least fifty times the amount needed for local treatment. Penicillin is absorbed from the alimentary tract, but cannot be given by this route because much of it is destroyed by acid in the stomach or by bacteria during rectal infusion. It must, therefore, be injected either intramuscularly or intravenously, the daily dose for an adult being about 120,000 units. This may have to be continued for seven days or even longer. A sudden and dramatic improvement is rarely seen, and sustained treatment, arduous for those in charge and disagreeable for the patient, is the price of success.

Extensive and deep-seated infections inaccessible by local applications require systemic treatment; these include osteomyelitis, severe cellulitis and gas gangrene. It has recently been shown in battle casualties from Sicily that potentially infected compound fractures can be closed with the aid of penicillin. Observations made in both the American and British armies have shown that cases of gonorrhea can be cured by a total dose of little more than 100,000 units given in a space of about twenty-four hours.

The local application of penicillin takes many forms, some calling for ingenuity which is well rewarded by the remarkable effects to be obtained at little cost. Application to burns and other superficial and accessible wounds is secured by a cream or powder, the only satisfactory diluent known for the latter being sulfanilamide. Similar applications are highly successful in the treatment of skin infections such as impetigo and sycosis barbae. The treatment of deeper wounds demands arrangements whereby a preparation can be enabled to penetrate them completely and persist there. A radical change in surgical technic is often necessary to secure this.

Thus an abscess cavity or other infected area which would normally be laid widely open and drained freely may either not be incised at all but treated by aspirations and injection of penicillin solution, or if incised, it may be sutured again and closed, except for a small aperture containing a tube through which the solution is introduced at intervals.

Common causes of failure are such morbid anatomical conditions that prevent the solution either from reaching all parts of the lesion or from persisting there, the presence of bacteria which are resistant to penicillin or actually destroy it, and antecedent fibrosis mechanically preventing closure and healing.

A special example of local treatment is the intrathecal injection of penicillin solution for the treatment of meningitis. This has been highly successful in a few cases, and is imperative for treating this condition, since penicillin, unlike the sul-

fonamides, does not pass freely from the blood into the cerebrospinal fluid.

Looking further into the future, it may be asked what prospects there are of extending the scope of this treatment. The full possibilities of penicillin itself have not yet been explored, even in infection by bacteria known to be susceptible. Extensive research is being conducted in its effect in gas gangrene, syphilis, diphtheria and anthrax. But is there any possibility that substances related to penicillin will be found which attack bacteria on which penicillin has little or no action? When the structure of penicillin becomes known it may be possible so to vary it that a wider range of activity is secured. One thing quite certain is that penicillin differs fundamentally from other antibacterial agents. Its discovery is an achievement of the first magnitude, of which the ultimate consequences cannot yet be foreseen.

LAWRENCE P. GARROD, M.D.

## FREDERICK C. HOLDEN

ON Sunday, August 27th, Frederick C. Holden, long a member of our Editorial Board, suddenly died at his summer home in Maine. In his passing this Journal lost a valuable staff member, and the editor a friend for over thirty-five years.

Dr. Holden had personality plus. He was a master organizer; he was an excellent teacher and took great interest in and developed the talents of many young men.

His honors were many. It would serve no useful purpose to recount them in detail. The high-spots cover: President of the Medical Society of the County of Kings; Associate Professor of Obstetrics and Gynecology, Long Island College of

Medicine; Director of Gynecology and Obstetrics, Greenpoint Hospital; Professor of Obstetrics and Gynecology, Medical School, New York University; Director of Obstetrics and Gynecology, Bellevue Hospital; President of the Brooklyn Gynecological Society; President of The American Gynecological Society; Director of Gynecology at the Margaret Hague Maternity Hospital, and Director of Obstetrics and Gynecology at the French Hospital, New York.

We will miss him, and the readers of this Journal will miss his behind-the-scenes influence.

T. S. W.



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# Original Articles

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## DELAYED RUPTURE OF THE SPLEEN\*

### CASE REPORT

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AND

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CHARLESTON, WEST VIRGINIA

**R**UPTURE of the normal spleen has greatly increased in frequency and is not considered the rarity it was formerly thought to be. The literature has recorded consistent increases,<sup>23</sup> explaining the reason for this as being due to greater industrial activity and greater use of the automobile.<sup>18, 20, 23, 24</sup>

Wright and Prigot<sup>23</sup> in 1939, in reviewing the cases at the Harlem Hospital in New York, reported that of 20,000 casualty patients admitted to the traumatic service, one in every 666 accidents had a rupture of the spleen. Roettig<sup>20</sup> in analyzing the admissions to the Ohio State University Hospital in Columbus reported an incidence of one ruptured spleen in every 920 accident admissions of all types. Similarly it has been estimated that injury to the spleen is the most common of subcutaneous injuries of the abdomen and its rise is more than apparent when it is seen that Mazel,<sup>13</sup> in 1932, noted an incidence of 30 per cent of rupture of the spleen, Bronaugh,<sup>6</sup> in 1935, noted an increase to 33.3 per cent, and Wright and Prigot,<sup>23</sup> in 1939, found the incidence to be 47.6 per cent. That is, the spleen is involved in 47.6 per cent of all subcutaneous injuries to the abdomen either isolated or complicated with other injuries. Therefore, injury to the spleen outranks trauma to the liver and to the kidney. Yet the diagnosis is too frequently missed. This pertains perhaps mostly to the delayed type of splenic rupture. All too frequently

diagnosis is made at autopsy (Roettig,<sup>20</sup> Butler and Birnbaum,<sup>7</sup> Henderson,<sup>11</sup> Blocker,<sup>4</sup> McIndoe<sup>15</sup>).

Difficulties in diagnosis<sup>7, 11</sup> have been described as follows: (1) Absent visible signs of injury to the anterior abdominal wall which permits the patient as well as the physician to disregard the early mild symptoms, since the reasoning is that the trauma sufficient to rupture a spleen should cause more visible signs of injury (Butler and Birnbaum<sup>7</sup>). This is well exemplified by a case reported by Bonfield<sup>5</sup> in 1937 of a man struck by a street car who appeared to be well the next day and was discharged from the hospital. The day following discharge he suffered sudden severe pain in the left upper quadrant, collapse, and presented all the signs of a grave internal hemorrhage. At operation a ruptured spleen was found. (2) The history may be misleading. Stretton<sup>21</sup> reported a case of a thirty-seven year old woman who stated she was seized with a most severe upper abdominal pain while getting out of bed. Further check-up of the history after operation revealed that she had been subjected to violent coitus two hours before the onset of her symptoms. Rankin<sup>19</sup> reported a case of rupture from muscle action occurring in a man pulling a cable. He quotes Susman 1927, and Bohler 1933, who both reported ruptures occurring in men who stooped to pick up a heavy object. Zuckerman and Jacobi<sup>25</sup> review

\* From the Charleston General Hospital, Charleston, West Va.

the subject of spontaneous rupture very carefully, that is a history of trauma cannot be obtained in cases they analyzed. (3) The shock the patient is in, is thought to result from associated injuries to the head, chest or extremities, or to alcoholism. That is, the patient may present more obvious symptoms from his associated or complicating injuries. (4) The recession of symptoms lulls the observers and patient into a false sense of security. Add to this the delay of the patient in seeking medical care; that is the time consumed in getting the patient to the hospital or the doctor to the patient from the onset of the accident; or the time consumed in combating the shock so that the symptoms of ruptured spleen may recede or become quiescent; or the difficulties in making the diagnosis in the presence of multiple injuries, can well explain why a rupture of the spleen can be overlooked. Puestow<sup>15</sup> reported such a case, in which rupture of the spleen was overlooked for twelve days after a patient suffered a fall of 102 feet which was complicated by fractured ribs, vertebra, and left leg. Almost every author who has reported any large series such as McIndoe,<sup>16</sup> Wright and Prigot,<sup>23</sup> Roettig,<sup>20</sup> Connors,<sup>8</sup> have recorded cases in which diagnosis has been incorrect, missed or overlooked. Here at the Charleston General Hospital we have had twelve cases of ruptured spleen from 1939 in addition to the case to be reported. All coincide with the accepted etiology that trauma either direct or indirect is always the initiating factor in rupturing a normal spleen.

There were three automobile and one motorcycle accidents, three gun shot or stab wounds, one patient dragged by a mine car, one fall from a scaffold, and only the remaining three were isolated cases of rupture of the spleen. One boy of thirteen fell across the rung of a ladder striking his left upper abdomen; a second boy age nine, was thrown against a tree stump while riding a sleigh. The third

case was the only case of prolonged delayed hemorrhage in this series comparable to the case to be reported, in the pathological sense; also no history of trauma was ever obtained from him. He gave a history of some stomach trouble one year previously but x-rays were negative. He had had no previous attacks and had been on a alcoholic debauch for the past three months. It was our assumption he may have suffered some unrecalled trauma during this time.

E. C. was sitting on a bench on May 28, 1940, at 9:00 A.M. when he was suddenly seized with an acute pain in his upper abdomen. He was brought to the hospital and an examination revealed a tender rigid abdomen. Blood pressure was 120/22; temperature 99.2°F; white count 16,900 with 93 per cent neutrophils. X-ray of the abdomen was negative. This case was diagnosed as perforated peptic ulcer and at operation the abdomen was found to be full of blood due to a ruptured spleen. A splenectomy was done and the patient made an uneventful recovery. The pathologist reasoned from the findings of a subcapsular hemorrhage of the anterior surface and a blood clot on the posterior surface, that a small rupture had occurred in the splenic parenchyma; the hemorrhage slowly working up to and finally penetrating the capsule.

This case is almost a word for word duplicate of the history of case No. 19 of Wright and Prigot.<sup>23</sup> This patient had also been on an alcoholic spree for three months and gave a history of stomach trouble one year previously, however, no stomach x-rays had been taken. While sitting on a park bench, he vomited. This was followed by a sharp periumbilical pain which radiated to the left shoulder, left side, and back. He became weak, dyspneic, and coughing produced pain in the right upper quadrant. He had several watery stools with blood and three chills that night. He was admitted to the hospital the following day, operated on for ruptured spleen and died one-half



hour later. No history of trauma was obtained. It is these cases which have been reported as delayed splenic rupture or cases seen during the "latent period" of splenic rupture which present major difficulties in diagnosis.

Rupture of the spleen non-operated, can be stated to be 100 per cent fatal.<sup>15,18,20,23,24</sup> The operative mortality is perhaps 25 per cent (Puestow).<sup>18</sup> The mortality in unoperated cases varies with the length of the latent period, but finally rupture does occur even as long as two years after the initial injury, in authenticated cases as reported by both Orator,<sup>17</sup> and Muller,<sup>16</sup> quoted by Zabinski and Harkins.<sup>24</sup> The usual length of the latent period is 52 to 60 per cent of the cases is one week,<sup>24</sup> 20 to 25 per cent more terminate in the second week and the remainder usually in forty days. A few cases have been reported as terminated in six months (McIndoe),<sup>15</sup> and two years (Orator,<sup>17</sup> Muller).<sup>16</sup> This is based on 179 cases of delayed hemorrhage as collected and analyzed by Zabinski and Harkins.<sup>24</sup> They also state that the ratio of delayed to immediate hemorrhage is one to six.

A fatal or grave hemorrhage always supervenes at the terminus of the latent period and spontaneous recovery does not ensue. Hamilton Bailey<sup>1</sup> in analyzing Watson's report of two specimens of ruptured spleen with recent scar tissue, concluded that these patients died from intercurrent accidents too soon before termination of their latent period (within thirteen days).

The reason for the termination of the latent period is linked to the type and extent of the initial injury to the spleen, and the anatomy and physiology of that organ. This tends to produce a progressive pathologic process.

The spleen is a vascular lymphoid organ weighing about 200 Gm. and normally 12 by 7 by 4 cm. in size. It lies suspended by the gastrolinal and phrenicocolical ligaments between the fundus of the stomach and the diaphragm, is freely

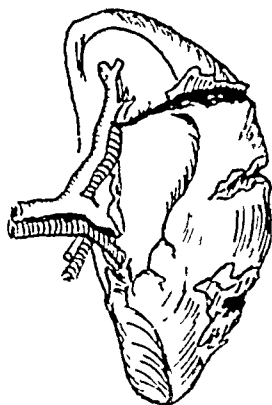
movable on its pedicle, is protected by the cushioning effect of the adjacent viscera and by the lower thoracic cage extending somewhat anterior and posterior. This gives the spleen a false sense of protection, because any directed and sudden blow anteriorly will compress it against the vertebrae or cause rupture by contrecoup. This explains the frequency of involvement of the hilum and resultant profuse hemorrhage. The minuter structure of the spleen is a large number of blood vessels and spaces or sinuses within loose friable pulp which is all suspended by a framework of trabeculae attached to the surrounding fibro-elastic capsule. Also the large vessels supplying the spleen run through the gastrolinal ligament. Thus a laceration of the spleen is a tear of a very vascular organ since the spleen is a reservoir for blood,<sup>3,12</sup> in addition to other functions. It has been shown that the spleen not only contracts under certain physiological and pathological conditions<sup>3</sup> as asphyxia, exercise, high altitudes and high temperature, carbon monoxide poisoning, hemorrhage, hypotension, low oxygen tension, emotional excitement, and the injection of adrenalin<sup>3,12</sup> but also undergoes constant, spontaneous, rhythmic contractions.<sup>2,3</sup>

This has an important effect on the stability of blood clots and the continuance of hemorrhage especially in the delayed case of hemorrhage. But of more import is the location of the injury and its extent which determines the fulminance of the case. Of the various classifications of injury, that advanced by Roettig<sup>20</sup> seems to be the most complete. (Fig. 1.) Each of the following types present a different clinical picture and an understanding of these will aid in the diagnosis. Treatment in all types is the same. Fortunately, for the more delayed or receding types, a period of observation can be initiated in which a ruptured spleen is suspected, until the diagnosis is made.

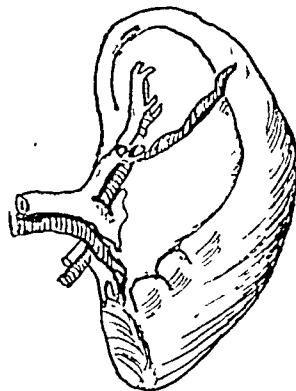
Type 1 is a complete fragmentation of the spleen into two or more parts or a complete tearing of the spleen from its

pedicle. This results in a massive hemorrhage and in many instances sudden death. This is likened by McIndoe<sup>15</sup> to the burst-

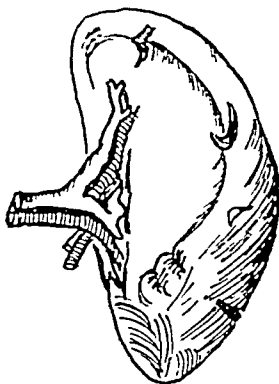
persistent development of the signs of intra-abdominal hemorrhage. This is the "repeated small hemorrhage" of Wright



Type I



Type II



Type III



Type IV

FIG. 1. Top: Diagrammatic representation of types I and II of splenic rupture, both leading to rapidly progressive hemorrhage. Variations of type I are a complete severance of the pedicle and a complete disruption of the spleen. Bottom: Diagrammatic representation of types III and IV of splenic rupture. Type IV is the lesion commonly responsible for the development of a perisplenic hematoma. (From Roettig et al.<sup>20</sup>)

ing of an aortic aneurysm. This is the "massive hemorrhage" of Wright and Prigot<sup>23</sup> and is Type 4 in the anatomic classification of Blocker.<sup>4</sup>

Type II represents a large tear at or near the hilus. This gives rise to grave hemorrhage. This is the "acute hemorrhage" of Wright and Prigot<sup>23</sup> and in the anatomic classification of Blocker<sup>4</sup> Type 3, is described as a deep pulp and capsular laceration. This type gives rise to shock shortly after the injury which becomes progressively deeper in a short while.

Type III is characterized by one large or multiple tears about the periphery of the spleen. This type leads to slow and

and Prigot<sup>23</sup> and may with the following type correspond to Type I of Blocker<sup>4</sup> "minor capsular tears and contusions of the pulp." This Blocker terms a theoretical group not based on operations, but this is false. This slowly progressive hemorrhage produces increasing anemia, a rising pulse, a falling blood pressure and weakness. Over a variable period the patient goes into gradual shock.

Type IV is characterized by a solitary tear at the periphery. This is the "late hemorrhage" of Wright and Prigot.<sup>23</sup> Symptoms here are of recovery after an initial injury and after a period of relief the patient goes suddenly into shock with

all the signs and symptoms of a concealed hemorrhage and gradually becomes worse.

Type v is a subcapsular hematoma and corresponds to Blocker's<sup>4</sup> Type 2 "intrasplenic or subcapsular hematoma." This may be the so-called "spontaneous cure" group of Wright and Prigot<sup>23</sup> but if so, this is not true since no instance of healed splenic hematoma has been found.<sup>1,14,22</sup>

In this paper we are concerned with the prolonged clinical course as may be exemplified by Types III, IV, or V. These types serve to explain the "symptomatic silence" or "latent period," coined by Baudet, from which the patient recovers from his shock and initial injury. The "latent period" is, therefore, that period of apparent recovery which follows the initial injury and is terminated by a reappearance of the signs of internal hemorrhage. The latent period has been arbitrarily set to begin forty-eight hours after the initial injury as defined by McIndoe.<sup>15</sup> During this period the patient should be practically symptom free. The latent period is suddenly terminated by the return of severe symptoms of abdominal pain and shock produced by the sudden release of a large amount of blood in the peritoneal cavity. This may occur so long after the initial injury that the accident is forgotten and the case is sometimes considered a spontaneous rupture. This, however, is usually disproved by the pathologic findings. Warning signals do exist during the latent period. These will be discussed later, but they usually consist of dull pain in the left upper quadrant, tenderness, digestive disturbances as exemplified in our case, and a rapid pulse rate and leucocytosis as described in the literature.

The length of the latent period as mentioned may vary. During this time the patient goes about his work and ignores or forgets the initial injury which may even be trifling.<sup>10</sup> This is what occurred with our patient. Then the latent period is abruptly terminated by a profuse secondary hemorrhage which is attended by the

same mortality as Types I or II of the primary rupture.

The episode of our patient preceding his present hospital admission is at least a tertiary possibly quaternary hemorrhage, on analysis. Fortunately, he recovered from his shock and further walled off the hematoma, but he would have progressed after a variable interval to a fatal hemorrhage as judged by the course of his disease. Recovering here is used in the sense of recuperating from shock and remission of acute symptoms. For to recapitulate, healed splenic hematoma have not been demonstrated.<sup>1,4</sup> This, however, accounts for the theories explaining the pathogenesis of the latent period, many features of which have been demonstrated in the literature as well as in our case.

Zabinski and Harkins<sup>24</sup> have gathered the following theories and observations:

1. *Temporary Hemostasis Produced by the State of Shock.* Hemorrhage is concomitant with the injury. Should the hemorrhage from a splenic injury be severe enough to produce shock, temporary cessation of bleeding is affected by the same processes as are seen in shock from other causes. This theory is more applicable to cases of immediate hemorrhage in which it is frequently noted that improvement follows the initial shock stage.

2. *Hematoma under Tension.* Intrasplenic bleeding may be made to cease by an enlarging hematoma which exerts compression on the contused pulp.

3. *Theory of Subcapsular Hematoma.* Demoulin expressed the belief that when bleeding is more or less abundant, the capsule is detached and forms a sort of hood in which clots collect. Then from any cause whatever, even from distention, the capsule ruptures, producing intraperitoneal hemorrhage.

4. *Formation of Clots at the Laceration (Werthmann).* Clots in various stages of organization have been observed rather frequently at the site of laceration. The extrasplenic clot is detached readily even by minimal effort.

5. *Tamponade by Omentum* (Mannheim, Rourier, Nest-Kolb). Plugging of the laceration by omentum is believed to be one of the most effective means of arresting hemorrhage.

6. *Tamponade by Stomach, Colon, or Adhesions* (Oudard and Guichard). The distended stomach or colon may seal the laceration. These organs help keep the clot in the laceration under tension.

7. *Theory by Perisplenic Hematoma* (Delaney, McIndoe). The spleen is surrounded by a potential space bounded on all sides by organs which are easily displaced. Hemorrhage from the injury surrounds the spleen, elevates the diaphragm, and displaces the splenic flexure of the colon and the parietal wall. Adhesions are formed, uniting the various organs and producing an enclosure which does not permit peritoneal flooding.

8. *Theory of Threshold of Hemorrhage* (Laporte). The organism can tolerate some hemorrhage but at a certain threshold signs of hemorrhage appear. This theory is borne out by those cases that have an onset prolonged over several hours.

More than one factor is undoubtedly involved. It has been shown that blood clots supported by omental tamponading makes the next efficient, but temporary hemostasis.

It has been noted direct violence causes parenchyma and capsular laceration while indirect violence causes hilar tears; slight trauma may produce severe injury. The convex surface and posterior border of the spleen is most commonly involved. This subcapsular area represents the flood region of the displacement of blood and is the area of greatest movement of physiological volume. In a tear of the spleen, the factors above to control the resulting hemorrhage can only be utilized if sufficient time is present so that these agencies can exert their effect. That implies the primary hemorrhage must be slow.

There are essentially two clinical types of secondary hemorrhage as distinguished

by Delannoy:<sup>9</sup> (1) Rupture with retarded symptoms which corresponds with a perisplenic hematoma, and (2) splenic rupture



FIG. 2. X-ray of the stomach interpreted "a polypoid tumor involving the lateral three-quarters of the cardiac end of the stomach."

with retarded hemorrhage which corresponds to intrasplenic or subcapsular hematoma. With the first type the patient is never or rarely free from symptoms, there is frequent gastrointestinal disorders, persistent tenderness, dull pain, slight rigidity or spasm, and some dullness in the left hypochondrium. He may have pain in the left shoulder, leucocytosis, and the temperature or pulse rate may be elevated. Our case seems to fall into this group. In the second group symptoms appear suddenly after an asymptomatic and variable period. The second group will often merge with the first.

The syndrome of symptoms follows the underlying pathological process of Types III, IV, or V, viz., a small subcapsular hematoma, or peripheral lacerations with a subcapsular hematoma or parenchymal tear. With a small subcapsular hematoma, parenchymal tear, or splenic contusion a slight maceration of the adjacent splenic pulp occurs. The spleen is unable to heal

this type of injury and a slow constant hemorrhagic oozing takes place into the splenic substance or subcapsular hematoma so that gradual expansion occurs, and by burrowing, the capsule is gradually stripped from the spleen, and the pulp is further macerated. This may attain considerable size and finally a slight rupture of the capsule is produced by some slight movement or effort so blood is released into the peritoneal cavity. This hemorrhage may be profuse or slight. If slight, formation of a perisplenic hematoma is favored, and this type then merges directly into the type produced by peripheral laceration of the spleen. At this point, however, exacerbation of symptoms are produced by free blood in the peritoneal cavity. Similarly, with a small tear of the splenic capsule, sufficient time is allowed for the omentum, colon, stomach, and diaphragm to encapsulate an area about the spleen walling it off with dense adhesions. The perisplenic hematoma may reach great proportions before the latent period is terminated, to break down the barrier of adhesions. This is the entire pathologic process we have traced in this case.

The symptoms and signs noted are, therefore, due to the progressive disorder. When the hematoma is small and confined within the splenic substance, there will be no symptoms. It has been thought a diagnosis of ruptured spleen could be made during the latent period and splenectomy performed before secondary hemorrhage took place. This is difficult when the hematoma is intrasplenic, but as the bleeding continues so that the spleen enlarges, dull pain produced as a result of tension on the capsule, with resultant tenderness to palpation, and possible rigidity of the overlying musculature, if the organ comes in contact with the anterior wall. Digestive disturbances are produced by pressure and displacement of the stomach or colon. The digestive disturbances result in nausea and vomiting, eructation, diarrhea, and constipation. Irritation of the diaphragm will produce

dyspnea, painful respiration, precordial pain, and possibly pain in the left shoulder due to displacement, and irritation of the phrenic nerve. Only in advanced hemorrhage will there be a rapid thready pulse, low blood pressure, cold clammy skin, subnormal temperature, air hunger, or apprehension. Dullness in the left upper hypochondrium is due to the gradually increasing mass. The blood count may be of very little value in a slowly progressing hemorrhage because if the fluid volume of blood is not augmented by the ingestion of liquids, there may be very little evidence of anemia by the blood picture. Irritation of the peritoneum may produce a relative or real leucocytosis, similarly ability of the vascular system to accommodate to alteration in the blood volume permits internal bleeding to continue to a marked degree before causing much alteration in the pulse rate and blood pressure.

Bleeding from the lacerated spleen irritates the splenic flexure and descending colon into contraction, thus causing diarrhea. This segment of bowel becomes paralyzed by aseptic peritonitis. This results in a partial intestinal obstruction which is followed by distention and may produce tenderness of the cecum in the right iliac fossa. Presence of blood in the peritoneal cavity may be determined by percussion. A fluid wave may be obtained. Fixed dullness in the left flank due to the enlarging hematoma and shifting dullness in the right flank due to free blood, may be present. This sign is said to be present at some time in the course of the disease, but is so inconstant as to be almost valueless.

Roentgen examination may be of value in establishing a diagnosis. There is usually increased density in the left upper quadrant of the abdomen, elevation of the left side of the diaphragm, displacement of the stomach to the right, and free fluid between the loops of intestines. The colon may also be displaced medially.

The constant symptoms in the following case were anorexia, weight loss, weakness, precordial and left upper quadrant pain,

and cough. To this were added hypertension with its associated features, and nocturia.

#### CASE REPORT

Mr. George W. Dix, a white male, age fifty-five, had been a miner for thirty-three years and was employed as a mine foreman up to the present. He was married, the father of four children.

He was first seen in the out-patient department of the Charleston General Hospital, June 10, 1943, where he had been referred by his local physician for removal of abscessed teeth for treatment of his hypertension.

Mr. Dix stated that he had first suffered a "spell" of high blood pressure, as far as he knew, six years ago when he was first aid man at the mine and helped carry out a miner, a known hypertensive, who had suddenly dropped dead in the mine. This frightened him so much he went to his doctor for a blood pressure check, and was told his pressure was slightly elevated. After a week of therapy his pressure was normal, but he continued to have periodical checks every two to four months and up to the onset of his present illness his pressure was always normal.

The history of his present illness was meager when he was first seen and was gathered piecemeal from his relatives, and from himself much later.

At this time he complained of dizziness and frequent headaches for the past two to three months and moderate cough with some precordial pain for the past five weeks. There was no expectoration. He had known his blood pressure was elevated the past few months. He stated he had been well until the Spring of 1943 when he first noted loss of appetite, gradual weight loss, and progressive weakness. This gradually became associated with dizziness, headaches, fullness and throbbing in his head and pain about the heart and left upper quadrant, and cough.

By early June this became so alarming he was unable to continue working and was forced to give up his job. He consulted his local physician who treated him for his hypertension and recommended extraction of his abscessed teeth, and referred him to our clinic.

He had had the usual childhood diseases, measles and mumps. In November, 1942, he had an attack of tonsillitis. He had had no surgery performed. Thirty years ago he had been kicked in the left chest by a mule, but

other than being sore for a few days suffered no ill effects.

His father had died at the age of sixty-five, when thrown from a horse, his mother died at sixty-five, and was discovered to have had diabetes. He had four brothers and three sisters living and well. One brother died at forty years of age, cause unknown and one died at twenty-three, an epileptic.

A routine examination revealed a blood pressure of 220/120 and about twenty abscessed teeth and pyorrhea. His urine presented normal findings, his blood count showed 82 per cent hemoglobin, 4,400,000 red cells, 8500 white cells, with 24 per cent lymphocytes, 73 per cent neutrophils, 1 basophil and 2 eosinophils. The color index was 0.93. An x-ray of the chest revealed the lungs clear and the heart normal in size and contour. He was thought to be suffering from essential hypertension and pyorrhea. Two of the worst abscessed teeth were extracted and he was instructed to have the remaining extracted at home.

He returned to the hospital November 9, 1943, irrational, complaining of epigastric pain, tenderness, and nausea. He was admitted to the medical service. Because he was irrational an adequate history could not be obtained from him; his relatives were solicited. He had been fairly comfortable since all the teeth were removed, but he had been gradually going downhill, becoming weaker, more nervous, unable to eat and sleep, and worried by the constant nagging dull pain in his lower left thorax. In addition since last seen he developed a nocturia of four to five times, something he had never had before. There was no dysuria, hematuria, or lumbar pain. He had been constipated the past three days.

About one month prior to admission the pain in his precordium and left lower thorax became more severe, so much so he was unable to get about and lived on "rest pills." On November 6, 1943, while stooping he developed an acute pain in the lower chest which doubled him up. This was accompanied by dyspnea, persistent vomiting, profuse perspiration, and marked cyanosis. He appeared to be dying. He became irrational and confused to such a degree his family observed he was out of his head. He was brought to the hospital three days later.

Examination revealed a well developed and fairly well nourished white male in no acute distress. He appeared older than his stated age. His blood pressure was 160/94, temperature

99.6°F., pulse 80, respiration 20. He was edentulous. The lungs were clear and resonant; no râles or impaired breath sounds were present. The heart was normal in size, regular in rhythm and rate, with no murmurs. The abdomen was slightly distended, somewhat tender in the left upper quadrant, but no localized tenderness, rebound tenderness, or rigidity were present. Rectal examination revealed a slightly enlarged, firm prostate. The genitalia were negative, the extremities normal. The impression was deferred pending work up.

X-ray studies of the kidney, ureter and bladder including *intravenous* pyelogram revealed no gross disorder, no stasis or dilatation. X-rays of the stomach were interpreted, "a polypoid tumor involving the lateral  $\frac{3}{4}$  of the cardiac end of the stomach." (Fig. 2.) Fluoroscopy revealed a slight displacement of the stomach to the right.

Laboratory studies revealed the serology negative, the fasting blood sugar 103.6; the sedimentation rate in one hour 146, in two hours 155; the blood amylase 1-64 (the upper limits of normal); the urine was acid, containing 1 plus albumen and 1 plus sugar, subsequent urines were negative for sugar. The blood revealed a hemoglobin of 52 per cent, red cells 2,800,000, white cells 15,000 with a differential of 31 per cent lymphocytes and 69 per cent neutrophils; the bleeding time was one and one-half minutes, the clotting time three minutes, the prothrombin time twenty seconds. An electrocardiogram revealed normal curves with a slight sinus tachycardia; the PR interval was 0.14 seconds, the rate 95 per minute.

He was diagnosed as a carcinoma of the stomach and transferred to the surgical service. Here he was prepared for surgery with daily blood transfusions and 10 per cent glucose, vitamins K and C and stomach lavages. On November 19th, under spinal anesthesia (18 mg. pontocaine supplemented later by cyclopropane), he was explored through a left upper paramedian incision. The stomach was normal throughout its extent but was adherent by the mesocolon throughout to a mass, the size of a fetal head in the left upper quadrant, which deflected it to the right. The omentum was slightly hemorrhagic with some slight streaks of fresh blood on its surface. The large mass in the splenic flexure was wrapped up in omentum, below this was a thick membrane, indurated, filled with clots, old blood and pulp, and identified as spleen. This was so soft and

friable that the pressure of separation caused the mass to rupture and an old hemorrhage exuded. The mass became smaller and was then detached from the stomach on its greater curvature, mesocolon, and lesser omentum with great difficulty. The pedicle of the spleen was then ligated and resected. Fortunately, the mass was so thrombotic very little free bleeding was encountered. A pack was placed in the splenic cul-de-sac to control oozing. Sulfathiazole crystals were placed in the abdomen and the incision closed anatomically. Because of the friability of the mass and difficulty in dissecting it from its attachments, inability to remove *en masse* and evacuation of hemorrhage when broken into, no old rent or site of fracture in the spleen could be demonstrated.

At operation the diagnosis of perisplenic hematoma by rupture of the spleen with delayed hemorrhage was made. The history was then gone into extensively postoperatively with the family. The patient was rational throughout his postoperative course, but was unable to remember any injury or accident even on repeated questioning until two weeks later, when he faintly recalled falling, after the history as obtained from his son was presented to him. He confided he had been unable to concentrate for the past six months and since March his mind had been foggy. When he did recall the fall he stated he had recorded it in his time book at the time of occurrence and had promptly forgotten all about it.

The following history as obtained from his son, is presented: The father on arriving home from work sometime in March, 1943, complained to the son of slight pain in his left lower chest anteriorly. He stated he had been putting up a jumper (half length pipe) in the mine, with a 24 inch Stilson pipe wrench. In tightening the pipe, his footing gave way on the wet uncertain ground, the wrench slipped from his hand and he was flung in a water hole and fell against the pipe on the ground striking his left side, upper abdomen and lower chest. He stated he felt as if he had broken a rib but he continued working and gave his injury no more thought, since he appeared to have no further trouble. His soreness left in a short while. It was very shortly after this that the symptoms relating to his present illness began.

The pathologist reported the specimen received consisted of a portion of the spleen and 375 cc. of blood clots. The spleen was 12 by 6 by 4 cm. It showed several recent but no

definite older tears. Its surface was covered with recent blood clots under which it was smooth. The capsule was thin, the cut surface bright red, soft and moist. The vessels were dissected from the hilum. Most of the omentum was with the specimen. This was very hemorrhagic and somewhat indurated. Some of the hemorrhages appeared older, showing brownish discoloration.

Sections from several areas of the spleen showed small follicles mostly with marked thickened hyalinized arterioles. The pulp was solid showing considerable infiltration with eosinophils, neutrophils and plasma cells. There was very little blood present. Sections from the omentum showed blood pigment, chronic inflammatory infiltration and organizing hemorrhage partly walled off by a fibrous capsule.

Diagnosis: Chronic infectious splenic enlargement; subacute perisplenic hematoma walled off by omentum.

The patient left the operating room table in shock. He was given 250 cc. of plasma with 10 cc. of adrenal cortex in the operating room. His blood pressure was 60/30, pulse rate was 110, weak, and thready, and respirations were 18. He was placed in an oxygen tent, given blood and intravenous glucose and more adrenal cortex. The following day his temperature rose to 102.8°F. and râles were present in the left lung. X-ray examination revealed a profuse infiltration throughout the lower half of the left lung due to a pneumonia. He was placed on sulfadiazine in addition to intravenous fluids and supportive medication, and in four days his temperature was normal. His pulse dropped from 120 to 100 and later to 90, his blood pressure rose to 150/100. From this time on his recovery was uneventful. His blood pressure on discharge was 140/76.

This case embodies all the difficulties in diagnosis and calls attention to the pitfalls and errors in interpretation of the existing signs and symptoms which one can expect, especially in this case but also in medicine in general. In cases of trauma one must be constantly alert to the diagnosis of rupture of the spleen. Another trite but important lesson is that the rendering of a hopeless pre-operative diagnosis does not necessarily condemn the patient and prohibit exploration; the possibility of error does exist.

In addition this case presented unusual features which are at variance with the literature on the subject and which further served to confuse the diagnosis. These were a hypertension of 220/120 with associated headache, throbbing, dizziness, and tinnitus, and a nocturia of four to five times which suddenly developed during the mid-course of the disease. The pulse rate and blood picture were apparently normal throughout until late. In addition the pain was mostly precordial until very late in the course of the disease, and he was in an age group in which cardiac conditions were most likely to occur. We are unable to explain the elevated blood pressure except that the gradually enlarging hematoma caused a chronic variable compression of the left kidney and/or the left renal artery, which is in line with Goldblatt's experiments. Of course the toxemia of pyorrhea and abscessed teeth may be a secondary factor. But in line with the above reasoning the sudden nocturia could only be due to pressure on the kidney which caused a decrease in the filtration capacity so that greater output would be necessary for the same amount of waste excretion. These are interesting lines to follow in this patient because following surgery his blood pressure dropped to the upper limits for his age group and his nocturia ceased. Furthermore his blood pressure on discharge may not be the true blood pressure because as Holman<sup>12</sup> has shown there is a temporary elevation of blood pressure following splenectomy which is due to the elimination of an area of lessened resistance or an increase in the peripheral resistance and in the volume of circulating blood with an extension of the circulatory bed by the volume of blood which has increased. This will bear further investigation.

#### SUMMARY

We present a case of delayed rupture of the spleen with perisplenic hematoma in a fifty-five year old male which coincides with the observation expressed by Zabinski



and Harkins<sup>24</sup> that "delayed splenic rupture is most common in males in the third decade of life."

This patient had recuperated from the shock of his late acute internal hemorrhage suffered thirteen days prior to surgery, and was operated upon eight months plus days after his unrecalled injury through a mistaken diagnosis of carcinoma of the stomach. The history and symptoms were all confusing and this case illustrates the difficulties in diagnosis and shows how insidious and treacherous this syndrome may be. He would unquestionably have gone on for a variable period before another possibly fatal hemorrhage occurred. Such a case helps explain the very prolonged cases reported in the literature.

The postoperative course was complicated by pneumonia from which this patient recovered.

His chief complaints during his early observation were those of hypertension with dizziness headaches, and fullness of the head, and anorexia, weight loss, weakness, cough, and precordial pain; later were added nocturia, epigastric and left hypochondriac pain, and nausea.

The unusual symptoms in this case at variance with the accepted literature on the subject of delayed rupture of the spleen are a hypertension (of 220/120) and a nocturia (of four to five times). This is difficult to explain except on the basis of the mass exerting pressure on the left kidney or/and left renal artery. Following surgery his nocturia ceased and his blood pressure dropped to 140/76.

The incidence of delayed rupture of the spleen in our five-year series of thirteen cases including this case, is two cases of delayed hemorrhage and eleven cases of acute hemorrhage (2 in 13). Of this group four cases including the present one, were isolated and uncomplicated cases of splenic rupture.

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# SURGERY OF THE COMMON BILE DUCT\*

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TO operate successfully upon the common duct it is necessary to be familiar with the anatomy histology, physiology and pathology of the duct. For the purposes of this paper the duct includes the right and left hepatic ducts and the sphincter of Oddi, together with the terminal end of the pancreatic duct or ducts.

One must also know the application of the underlying principles of surgery to the peculiar tissues concerned. Injury at operation is practically always avoidable. Operations on the biliary tract should be done only by well trained surgeons. Younger men should associate themselves with such surgeons and learn the gentle, accurate technic necessary to success.

To quote Moynihan, "secondary operations upon the biliary system are among the most difficult tasks in surgery. To obtain the best results all the highest qualities of the surgeon may be called into play: courage, resource, patience, accuracy, and rapidity of judgment, the finest craftsmanship, and a tranquility of mind and action that nothing can disturb."

In suturing use fine needles, fine silk, split the duct wall, avoid the needle entering the lumen, if possible, above all gentleness. Suction of hepatic ducts for a stone that is located high up is at times useful. Irrigations for such stones or for débris is useful. Operations on the common duct should be done without disturbing the position of the duct by traction. When using stay sutures so place them as to be useful later in closure of the duct.

Kinking of the duct through traction should be avoided as in incising the anterior

wall injury to the posterior wall may result.

The ordinary incision of the duct for exploration should be longitudinal. A supplementary incision may be necessary in case of an impacted stone and this supplemental incision should be repaired.

In resection of the common duct it is best wherever possible to cut obliquely to prevent undue contraction in healing. The use of a Vitallium tube obviates this precaution.

Stretching of the sphincter of Oddi should be done only when actual stricture at that point is present.

In differentiating glands along the common duct from stones in the duct a fine silver probe is useful. When in doubt a cambric needle held by a clamp is useful, though a calcified gland at the end of the common duct may give the impression of a stone. Such glands do give pressure effects and require removal.

Care should be taken in applying the r-clamps to the cystic duct that the direction in which the clamps are placed is away from the common duct. This also applies to clamping accessory small vessels between the cystic duct and the liver. Such procedures should be visualized.

In probing of the common duct through a partially sectioned cystic duct traction must be avoided or the common duct may be so kinked that even a small flexible silver probe will not pass. Several varieties of probes are useful. I prefer flexible silver probes in medium sized ducts, lead probes in larger ducts, and flexible olive tipped probes at times.

A thickened common duct requires incision.

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Needling to differentiate stone from inflammation or tumor is at times useful.

The best way to avoid injury to the duct is by visualizing and demonstrating each step. I have found elevation of the head and trunk very useful as a position in which to operate. This position is secured by elevating the upper portion of the patient from the shoulders to the level of the ensiform to a height of six to eight inches with comfortable position of the head and neck. This may be accomplished by a special framework, by air cushions or by an elevator attachment on the table in conjunction with ordinary soft pillows. This position places the head and trunk on a higher level than the abdomen, it is comfortable, and anesthesia is taken well. On opening the abdomen gravity aids in displacing the intestines downward. Later when the abdominal wall is about to be closed the patient is levelled and just before this is done the anesthetist is told so that the depth of anesthesia may be slightly increased to avoid the patient's coming out when the head and trunk are lowered. No complaint of backache has been made by patients so elevated.

Other desiderata are assistants that stay put and excellent anesthesia. Under these conditions the work is much simplified.

To avoid injury to the common duct it is necessary to know not only the usual anatomical arrangement, but also the anomalies not only of the common and hepatic ducts but also of the cystic duct and the arteries of the region, particularly the cystic artery or arteries, and the hepatic artery and right and left hepatic arteries.

Identification of the cystic duct and T-clamping it near the gallbladder first is important. This avoids entrance of small stones into the cystic duct and into the common duct. The identification and clamping is usually a simple matter. However, it may prove difficult under certain circumstances: (1) The cystic duct is adherent to the common duct.

(2) The ampulla of the gallbladder is adherent to the common duct. (3) The cystic duct is greatly enlarged and shortened. (4) The gallbladder is funnel-shaped without any infundibulum. (5) The cystic duct enters the common duct high up, sometimes even in the liver itself and rarely into the right hepatic duct. (6) The cystic duct is parallel with the common duct either external or internal to it, entering the common duct low down or joining the common duct at the ampulla of Vater. (7) When there is no cystic duct the hepatic ducts enter the gallbladder directly and the common duct leaves the gallbladder directly. (8) The common duct forms a half curve with the cystic duct entering the curve at right angles. (9) The cystic duct encircles the common duct. (10) There are two cystic ducts, and (11) when there are anomalies of the arteries, either cystic or hepatic.

Identification of the common duct is easy when the normal relationship exists, but in the presence of adhesions may be extremely difficult as is also the case when the gallbladder has previously been removed. Hypodermic exploration for purposes of identification is at times useful. One must be particularly careful when the cystic duct parallels the common duct as it at times does.

When choledochus stone is even suspected, operation is indicated as soon as the patient can have the necessary preparation to forestall hemorrhage and liver shock (vitamin K and glucose). Delay may result in cholangitis ranging from catarrhal to suppurative with serious involvement of the liver, hepatitis, biliary cirrhosis and pancreatitis.

Exploration of the common duct is not attended with increased mortality. It is delay in operating which increases mortality.

Simple choledochotomy will usually suffice. If not, a direct attack or a retroduodenal incision may be done. The transduodenal is least desirable.

The gallbladder may be first emptied of its stones to prevent further entrance of stones into the common duct (Walters). I prefer suction emptying of the gallbladder to give better access,  $\tau$ -clamping of the cystic duct to prevent other stones entering the common duct, thorough visual and digital examination of the common duct, partial section of the cystic duct with introduction of a slender silver probe, shaped like a question mark, through the cystic duct into the common duct, and then again digital examination of the common duct with the probe in the duct and duodenum. Small stones can thus be usually differentiated from glands.

Following localization choledochotomy is performed in the visualized course of the duct and the stone or stones removed. If a stone is absolutely immovable, an incision is made at the site of the stone (retroduodenal or rarely transduodenal). If a freely movable stone slips too far upward, suction of the duct or ducts is instituted to bring it down and out together with  $\tau$ -tube drainage.

When in doubt, open the duct; otherwise small stones may be overlooked. In all cases in which the duct shows some pathological process (marked dilatation or thickening), the duct should be opened. Slight dilation may be compensatory to gallbladder dysfunction.

Remove stones gently; avoid crushing by pressure or scoop. In chronically dilated ducts (thick-walled), I find a  $\tau$ -clamp useful in determining the sufficient patency of the ampulla of Vater. It must be used gently and the sphincter of Oddi must not be overstretched. It is nature's safeguard against regurgitation of duodenal contents.

Complicating pancreatitis must at times be dealt with (drainage of the head of the pancreas). Occasionally, cancer of the pancreas will complicate the condition. Fortunately, we do not often see the terribly advanced pathological processes of years ago. Operation is done earlier in biliary disease.

Resection with end-to-end anastomosis is indicated when there is sufficient duct above and below the site of stricture to allow of accurate approximation without tension. The duodenum should be mobilized. A  $\tau$ -tube, a catheter or Vitallium tube is used for reconstruction. If a  $\tau$ -tube or catheter, plain or banded, is used, reformation of the stricture is possible. The catheter should project into the duodenum so as to favor final extrusion. A simple longitudinal incision of the stricture with  $\tau$ -tube or catheter drainage cannot be relied upon to prevent recurrence of the stricture. A longitudinal incision with transverse suturing also cannot be relied upon. The Vitallium tube may be more successful. Further experience with it is necessary.

Choledocho- or hepaticoduodenostomy may be done immediately or may follow preliminary duct drainage for relief of jaundice. This was first successfully done by W. J. Mayo in 1905. C. H. Mayo used a rubber banded catheter over which to reconstruct the ducts. Such a catheter will remain *in situ* longer. The anastomosis must be accurate and without tension to obviate as far as possible formation of a stricture. The vitallium tube may make for greater success.

The operation to be used can be decided upon only after careful consideration of all factors, particularly local conditions. These operations are very delicate. The immediate results are usually excellent. The mortality is high. In eighty cases at the Mayo Clinic the mortality was  $12\frac{1}{2}$  per cent; the morbidity is also high; in the Mayo Clinic it was  $12\frac{1}{2}$  per cent. These results are, of course, due to the long-standing disorder. Thickened ducts and liver dysfunction from long continued infection do not lend themselves readily to cure.

The transplantation of an external biliary fistula of the common duct into the stomach or intestine must occasionally be resorted to in cases in which destruction of the common and hepatic ducts is so

extensive that no form of anastomosis or reconstruction can be attempted with any hope of success. The field of application of such a method is limited. This operation was originally used in cases in which a biliary fistula of the common duct had been established for relief of stricture. Since then it has been used in cases in which at operation the possibility of restoration or plastic formation of a new duct was thought to be impossible. The method has proved successful in a small number of cases at the hands of several operators. Thorough exploration should be done before using a fistula for drainage purposes in order that no stones be overlooked. It must be emphasized that this method should be used only in complete stricture of the common and hepatic ducts in which insufficient normal duct remains between the liver and the strictured portion to permit direct anastomosis to the duodenum or stomach. Usually there is at least a stump of the common or hepatic duct embedded in the liver which will allow of some form of reconstruction or anastomosis so that only rarely need a fistulous tract be used. The method used by Walters of the Mayo Clinic is as follows:

"If biliary fistula transplantation is decided upon, the tract should be coned out, leaving considerable thickness of tissue around it, which allows it to remain attached to the liver. This is done to keep the fistulous tract open and to preserve its blood supply. As soon as the coned-out fistulous tract has been sufficiently mobilized, the nearest accessible portion of the stomach or duodenum is approximated and a stab wound is made into it at a favorable spot. A silk suture is passed through the end of the coned-out tract and this is brought through the opening in the duodenum or stomach and carried out again through the intestinal wall about 2.5 cm. lower, in the same manner as that used in ureteral transplantation. The fistulous tract then should be pulled through the opening in the

wall of the stomach or duodenum by the silk suture, which is so tied as to hold the end of the artificial duct inside the lumen of the stomach or duodenum. Interrupted sutures then close the opening in the intestine around the tract and further protection is afforded by a small piece of omentum."

I have used this method unsuccessfully in one case in 1915, in which I implanted the fistula into the duodenum for a persistent fistula of the common duct in which a plastic operation had failed on account of the extensive pathological changes present.

*Choledochography.* Immediate choledochography injecting 10 to 20 cc. of hippuran or brominol (brominized olive oil) into the common duct by needle at the operation, and immediate x-ray and interpretation may be valuable but certainly is time consuming. It does not seem to be a practical routine procedure and probably never will take the place of choledochotomy.

To the experienced surgeon the pathological appearance of the common duct should present evidence to indicate choledochotomy; while in those ducts in which the wall appears normal and in which distention of the duct is evident, it would be wiser to explore through the stump of the cystic duct or by direct incision in the common duct. One must, however, give great credit to Pablo L. Mirizzi, of Córdoba, Argentina, for his studies of the functional disturbances of the choledochus and hepatic bile ducts.

Postoperative choledochography has a distinct place in surgery of the common bile duct. This is done through the T-tube and has great practical importance in demonstrating overlooked stones, persistent dilatation of the choledochus, variations in shape in the region of the ampulla of Vater and in the region of the pancreas. Regurgitation into the pancreatic duct is at times demonstrated. Studies of this kind may determine the length of drainage necessary and the possibility and nature

of further operative treatment. Obstructions at the duodenal opening of the common duct can be demonstrated and differentiation made between malignancy at the end of the common duct and benign lesions of the pancreas. It is certainly an aid in difficult cases.

*T-tube Drainage.* Removal of the tube depends upon the lesion for which drainage is used. Many operators prefer to insert the T-tube after incising the common duct for thorough exploration, rather than to suture the duct and employ extraneous drainage. In such cases it is a custom of these operators to remove the tube in eight to ten days. Personally, I do not incise the duct unless there is some demonstrable pathological process. My exploration is done in the non-inflammatory cases through the stump of the cystic duct which is then clamped and tied, though, at times, I have instituted drainage through a large cystic duct.

Cases of cholangitis require much longer drainage, at times six to eight months with irrigation of the ducts through the T-tube.

Carcinoma of the head of the pancreas in which the gallbladder is not adaptable for drainage (cholecystenterostomy or cholecystogastrostomy) or in which the gallbladder had been previously removed, or in which the condition of the common duct does not permit of choledochenterostomy requires permanent drainage with the lower leg of the T-tube extending beyond the area of pressure caused by the pancreas.

The more disease process I find in the common duct, the more apt I am to institute long continued T-tube drainage with washing out of the duct. When it is decided to remove the T-tube tests are made as to the ability of the common duct to pass bile along through the arms of the T-tube into the duodenum, by tying off the end of the tube at first for a few hours, then for longer and longer periods, until the tube is finally tied off for several days. If, at any time, leaking occurs alongside the tube or epigastric pain is complained

of, the tube should be allowed to run freely and be again irrigated.

Clamping the tube off at various intervals and observation of the result as to absence of pain or jaundice or leakage about the tube is the usual method. When it is possible to have the tube clamped off for a week without symptoms, the tube may be removed. Again, let me warn that the pathological condition for which the operation had been done must be borne in mind. At times we use a T-tube, one end of which projects into the duodenum in cases of cancer of the pancreas. In such cases a tube must be kept in indefinitely, or until some other form of bile drainage be substituted.

The use of cholelithography may determine the size of the duct and its return to normal size. In doubtful cases these may be taken several weeks or months apart. Walters believes that when the brominol is emptied into the duodenum in ten minutes the tube may be removed. Of course, cholelithograms are particularly useful in showing evidence of stone or obstruction, for which other operative procedures must be done.

I have not experienced any stricture of the common duct from the long continued use of the T-tube. I have seen strictures in cases in which resection of the common duct was done and in which a T-tube was used for purposes of drainage as part of the resection. This is explained, I think, by the fact that when any circular duct is cross-sectioned, the ends have a tendency to contract. It is not caused by the T-tube but by the resection itself. Nature has a tendency to cause such wounds to contract.

This condition of contraction I have seen exemplified in cholecystenterostomies in which the jaundice of pancreatic obstruction of the lower end of the duct has been cleared up by a cholecystenterostomy and after several months has returned, whereupon a secondary operation has shown that the cholecystenterostomy had closed, not only as shown by the jaundice, but also demonstrated at the

second operation by the enlargement of the common duct, cystic duct and gall bladder. As further proof, the condition has been relieved by a re-establishment of the cholecystenterostomy.

The length of drainage in cases of cholangitis will also depend upon the character of the bile discharged. Cloudy bile indicates continuance of the drainage and irrigation; clear bile, normal appearing, is an indication for removal of the tube after proper precaution of shutting off is done.

Where in cases of stone the drainage is clear and suddenly stops, one is to suspect a stone higher up above the T-tube. When, as sometimes happens, a sudden stoppage is accompanied by jaundice and irrigation does not relieve the condition, the injection of a few cc. of brominized olive oil and an x-ray of the biliary tree will probably disclose the site of obstruction.

There are some cases of cholangitis, however, in which while a plentiful supply of bile is discharged through the tube, and while there is bile demonstrated in the stools, jaundice persists. This means that there is destruction of the liver about the finer radicles sufficiently extensive to cause jaundice in spite of drainage. Such patients usually die. The bile which is discharged contains considerable detritus as evidenced by liver destruction.

In cases of reconstruction of the common duct in which the injury has involved the entire circumference of the duct, and in which it has been necessary to resect scar tissue and to freshen both open ends of the duct, it is better to employ a Vitallium tube rather than a T-tube, as a T-tube in such cases is sometimes followed by stricture.

Where there has been extensive chole-  
dochitis, it is better to leave the T-tube in for a considerable time.

The T-tube is removed by grasping it firmly where it emerges from the wound, using a large piece of gauze and in the other hand an additional piece of gauze to prevent splattering when the T-tube comes out. The patient is instructed to take a

deep breath and steady traction is made on the tube. Very little traction is usually necessary; the tube comes out easily. There is a slight escape of blood which is controlled by pressure over the external wound opening. In five or ten minutes this stops, a dry dressing is applied and the patient is instructed to change the dressing when soiled. Very often there is no further escape of bile. At times, there may be a slight escape of bile for a few days but the resulting sinus quickly heals. Knowing of the experience of other operators, I have been rather anxious for the first few weeks as to whether or not there would be any recurrence of the symptoms.

In repairs of the common duct there have been three instances in which further repair was necessary, owing to further contraction in a syphilitic duct in one case, and stricture formation in two cases, in both of which the original injury of the duct was of a nature to involve its entire circumference.

From now on it is my purpose to use Vitallium tubes in cases of chronic chole-  
dochitis with extensive thickening and practical obliteration of the lumen of the duct for a considerable distance, and also in those cases in which stricture may be expected through the destruction of the entire circumference of the duct.

The epithelial lining of the common duct grows quickly, and is a great aid in reconstruction. In the first case, a syphilitic obliteration of the common duct, I relied upon this and while it was necessary after some months to reoperate, a considerable portion of the duct had regenerated.

*Injuries.* Wounds of the bile ducts other than operative are usually accompanied by injuries to the liver, so when the latter are operated upon it is wise to explore the gallbladder and ducts in addition to the liver injury. Injuries to the bile ducts alone are very rare. As there are no immediate localizing symptoms, they remain unrecognized for a time. Following trauma of the epigastrium or right hypochondrium the detection of increasing intraperitoneal effusion, iliac

dullness, bile pigments in the urine, light colored or white feces and jaundice, which is not always present, are indications for exploration.

Intraperitoneal effusion of bile in the absence of infection does not produce peritonitis. When the effusion is quite rapid, paracentesis is indicated and later operation on return of the effusion. Prognosis is bad when infection occurs; early operation is best.

In recorded cases operation has been limited to drainage of the subhepatic area or direct drainage of the hepatic or common ducts. Recovery usually follows.

If the tissues are infiltrated no prolonged search should be made. As stated, drainage usually suffices. Such operations have been done from the second to the forty-second day.

On account of infiltration by bile any reconstruction operation is difficult. If the lesion admits of demonstration simple T-tube drainage should be done, or failing identification neighborhood drainage. If the duct is completely torn across reconstruction should be attempted, or if impossible, a T-tube or Vitallium tube should be used with omental protection.

Whatever the method of treatment (simple drainage, repair or T-tube) used, subsequent contraction with stricture may follow depending upon the character of the tear (extensive and irregular) in the common duct. A metal tube is indicated.

As a surgical curiosity I mention complete tear of the cystic duct in which ligature of the duct and cholecystectomy was done successfully by Lessing.

Lejars reports an interesting case of rupture of the hepatic duct, situated very high up, and operated upon at the end of five weeks, in which M. Garré was compelled to confine himself to packing and drainage. The patient returned to the hospital a year and a half later deeply jaundiced. Owing to the impossibility of dealing directly with the cicatrix in the canal, Garré incised Glisson's capsule at a part of the left lobe of the liver where the superficial bile ducts appeared greatly

dilated, and anastomosed the incision to an opening in the duodenum. The jaundice disappeared, and permanent recovery followed this hepaticocholangioenterostomy.

*Tumors* involving the common bile duct are intrinsic and extrinsic. The intrinsic tumors include papillomas, lipomas, fibromas, xanthomas and adenomas. Tumors may also involve the stump of the cystic duct following cholecystectomy. W. J. Mayo has reported two such cases in which partial obstruction of the common duct was present and in which resection with reconstruction of the common duct resulted in cure. Comfort and Walters have reported a neuroma of the cystic and common ducts successfully resected and well eight years postoperatively. Duct tumors are rare. They have no characteristic early symptoms. Late symptoms are those of progressive jaundice. Even at operation it is sometimes difficult to establish an exact diagnosis. Hypodermic injection of the duct at an exploratory operation with immediate x-ray by the method of Mirizzi is helpful but time consuming.

Malignancy of the common duct is very rare. It can be diagnosed only at operation. As in other lesions of the common duct causing jaundice operation should be done as soon as possible.

The location of the tumor will govern the operative procedure employed. Usually these cases are so advanced that cholecystenterostomy is all that can be done. It is necessary to know just where the cystic duct enters the common duct and that the disease is below their junction so that the anastomosis may function.

Extrinsic tumors causing pressure are comparatively common. They are usually of the pancreas but may be of stomach or duodenum. I have had one case of carcinoma of the hepaticoduodenal ligament.

In excision of the cystic duct for tumor the gallbladder must also be removed and if necessary a portion of the common duct with reconstruction. If the tumor is situated high up on the common duct, resect if possible with hepatico-duodenal



anastomosis; if situated in the course of the common duct, carry out resection and end-to-end anastomosis or hepaticoduodenostomy. If the tumor is located in the duct, do a cholecystenterostomy when the cystic duct is above the tumor. Tumors involving the terminal portion of the common duct (duct wall, ampulla, pancreas, duodenum) are usually too advanced for resection so a cholecystenterostomy is the operation of necessity.

In regard to pancreatic tumors it is hard at times to tell whether the enlargement of the head of the pancreas is malignant or inflammatory. I have had several patients alive and well many years following cholecystenterostomy which at operation were thought to be malignant. There are many such cases in the literature. In cholecystenterostomy accurate layer by layer suturing is to be done with additional sutures to obviate tension. In cholecystogastrostomy Walters sutures the anterior stomach wall to the falciform ligament of the liver to avoid tension.

In certain cases of intraliver duct involvement by tumor, curetting of the obstructed duct in case of right or left hepatic duct involvement is carried out with T-tube drainage (Walters), and occasionally hepaticocholangioduodenostomy. Of course, these operations are palliative only.

Tumors involving any duct are to be resected whenever anastomosis of any kind can be done. As yet, no one apparently has used the gallbladder as a tube to connect duct or ducts with the duodenum. Such a solution could rarely be utilized.

Transduodenal excision involves a mortality of 38 per cent, retroduodenal excision, a mortality of 50 per cent, resection of the duodenum with duct tumor, a mortality of 35 per cent. These operations are risky and the recurrences rapid.

When terminal duct tumors or extrinsic tumors involving the terminal duct are thought resectable, cholecystjejunostomy should replace cholecystduodenostomy or cholecystgastrostomy in order that not only may the jaundice be relieved but

that later resection with gastroenterostomy be made easier. Whipple has devised a two-stage operation, at the first stage of which posterior gastroenterostomy and section of the common duct below the cystic duct, and cholecystgastrostomy are done. At the second stage several weeks later Whipple performs a resection of the first portion of the duodenum with removal of the affected portion of the pancreas and all glands, and the portion of the common duct previously sectioned, with ligation of the pancreatic duct or ducts and suturing of the cut surface of the pancreas. The duodenal openings are closed.

Any operation which relieves the jaundice some time before the resection is attempted makes for safety. Cholecystjejunostomy leaves a freer field for subsequent resection of all affected tissues. By using a long loop sufficient jejunum is left for subsequent gastroenterostomy at a time when the patient is jaundice free and in better shape for the extensive procedures necessary. Cases usually present themselves at too late a stage for any but the first stage; nevertheless, cholecystjejunostomy and not cholecystduodenostomy or cholecystgastrostomy I think is preferable and a second exploratory operation done under more favorable conditions.

*Biliary Dyskinesia.* After removal of the gallbladder there occasionally occur attacks of pain similar to the original attacks. When of mild nature, not occasioning much discomfort, they are usually relieved by diet. Occurring soon after a cholecystectomy for a gall bladder which was not marked disabled as to function, the cause is found in spasm of the sphincter of Oddi and dilatation of the common duct in nature's attempt to have the duct take on the pressure function of the gallbladder. These symptoms usually last for about six months when the sphincter of Oddi accommodates itself and the common duct has enlarged. In the totally disabled gallbladder we do not have this syndrome following. A patient with symptoms which persist after a cholecystectomy

for a practically functionless gallbladder and in which at operation the compensatory dilatation of the common duct has been demonstrated should be operated upon and the common duct opened and explored. The surrounding area should also be carefully explored. Pains occurring under these conditions are usually overlooked stones in the common duct. It is so easy to overlook a small stone in the common duct or small stones in the hepatic ducts. Hepatic duct stones, so-called liver stones, are usually small black, or blackish brown, and flat. When such stones are found at operation it is wise to drain the common duct as well as to flush out the hepatic ducts and also to suction the hepatic ducts. All procedures must, of course, be extremely gentle to avoid injury.

Other causes of pain simulating the original attacks are duodenal ulcer situated low down on the posterior wall of the duodenum not possible to visualize with x-ray (Mayo Clinic), pancreatitis and stricture of the common bile duct. A study of the contributions of Mirizzi, Best and Hicken will be of value in differentiation by cholangiography and choledochography. Again, let me emphasize that a patient suffering recurring pain not thought to be compensation of the sphincter of Oddi and of the common duct due to removal of a partially disabled gallbladder should be operated upon and a thorough exploration of the duct done. Walters believes that forcible dilatation of the sphincter of Oddi to a diameter of 6 mm. using graduated sounds and prolonged T-tube drainage should be done in cases in which there is inflammation of the duct wall. In any event, it is my belief that prolonged T-tube drainage with thorough exploration will result in relief irrespective of the dilatation of the sphincter of Oddi, provided a medium-sized probe passes freely. Stricture, of course, will require the usual operative treatment of choledochoduodenostomy if the stricture is not susceptible to resection. Cho-

langitis is another cause which also requires prolonged T-tube drainage of the common duct with irrigations.

Absence of the common duct is rare. *Congenital obliteration* of the duct is also rare and is usually due to errors in development as the ducts change from the solid state to a vacuolated state, later the vacuoles coalescing. Development may stop at any stage, resulting in complete obliteration or stricture.

Other causes are congenital syphilis, fetal peritonitis and inflammation of the duct itself. In the forms due to errors in development there may be absence of any or all of the ducts, or atresia of any or all the ducts. In some cases there is an absence of extrahepatic ducts, the gallbladder emptying directly into the duodenum. In other cases it may be the character of the bile itself which is at fault, inspissated bile causing complete obstruction. In other cases due to error in development the common duct may be extremely small, in which event the obstruction is partial.

As to whether such cases are amenable to treatment can be decided only at operation. The disease process resulting from congenital anomalies and inflammations may be so extensive in the liver that no operative procedure will be of any avail.

Symptoms are such as follow common duct obstruction and jaundice may be present at birth or may appear a few days or a few weeks later and is progressive with the usual pathological changes in all tissues.

Ladd has reported forty-five cases of congenital atresia of the bile ducts. The majority of patients unoperated upon die within six months. In Ladd's series forty cases showed complete obstruction. Of these, thirty-seven presented possibilities of cure. Sixty per cent of the patients operated upon recovered, remained free from jaundice and developed normally. Ladd advises operation between the second and fourth months, choledochoduodenostomy being the operative choice.

# HIP MOTIONS\*

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THE complete range of normal motions of the hip joint has never been clearly presented, nor have the characteristic limb in the other planes. For example, the normal limit of flexion of the hip when there is no lateral or rotary motion is

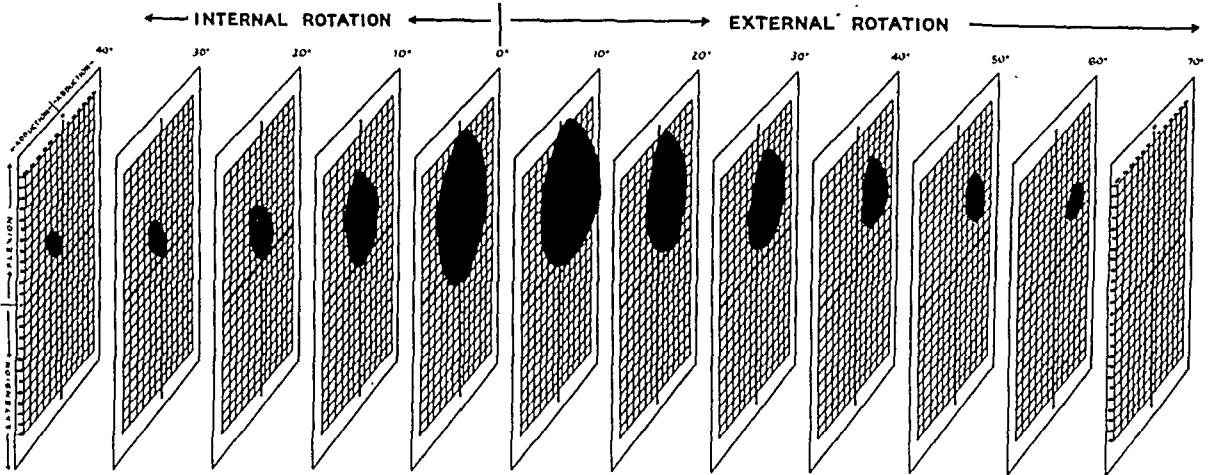


FIG. 1. Three-dimensional graph showing normal hip motion. By means of this graph, hip motions are simply, yet accurately and completely charted. Each sheet of the graph represents the range of anteroposterior and lateral motion at the specified degree of rotation. Flexion is represented above the abscissa axis, extension below it. Abduction is to the right of the ordinate axis and adduction to its left. It can be seen how anteroposterior and lateral motion vary with different degrees of rotation. It also can be quickly appreciated that each hip disorder has a characteristically-shaped global mass.

motion patterns of the important disease conditions here been fully described. It is appreciated that diagnosis cannot be made by determination of joint motion alone; but it is an important part of the examination, and if it is done at all, it should be done properly. Exception of course is made in the case in which extensive examination would too greatly increase the patient's discomfort.

Anatomy, physical diagnosis, orthopedic and other texts, as well as current articles, variously and incompletely describe motion here. Usually, each motion is described singly and it is said that normal flexion is 120 degrees, extension 20 degrees, abduction 35 degrees, etc. This is most incomplete as the limit of motion in any one plane depends upon the position of the

limb in the other planes. For example, 120 degrees, but when slight abduction and external rotation are allowed, 10 more degrees of flexion are possible. It is possible to chart the simpler motions in a single plane graph, but in order to chart circumduction a three-dimensional graph (Fig. 1) is necessary. Inspection of the graph shows many interesting facts. Note that the greatest range of anteroposterior and lateral motion is found between 0 degrees and 20 degrees external rotation. It is also seen that in slight flexion and moderate abduction, the maximum of external rotation (70°) is found; also, between 10 degrees and 30 degrees flexion and 20 degrees of adduction, the maximum (40°) internal rotation occurs.

If we visualize hip motion as depicted by this graph, we can see that a coxa

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vara with limitation of abduction shows a flattening on the right side of the cube. A defect is found in the internal rotation-

consequent defect in this portion of the three-dimensional graph. The Lasegue,<sup>2</sup> Ober<sup>3</sup> and Freiberg<sup>4</sup> signs also have to do



FIG. 2. Hip arthrometer. This shows the arthrometer in use. The hip in this case is being held in  $42^\circ$  flexion,  $15^\circ$  abduction and  $37^\circ$  external rotation. There is no rotation of the pelvis. If the pelvis moves, its motion may be noted on the protractor measuring this motion, but it is not reflected on the hip arthrometer and so does not cause an error in this reading.

adduction part of the graph on posterior slipping of the upper femoral epiphysis. A malunited fracture of the neck with external rotation and coxa vara deformity shows an increased external rotation and adduction with a decrease abduction and internal rotation. These and other points are demonstrated in detail in the case reports which follow.

In our routine examination, certain signs are looked for to which are attached the names of those who originally described them. We do not belittle them or discourage their use, but it is our belief that these can be more clearly interpreted if they are fitted into the complete motion graph. One of these is the Patrick<sup>1</sup> sign which was originally described to indicate arthritis of the hip. This sign is positive when there is limitation of extension of the flexed, externally rotated and abducted hip. This limitation of motion shows a

with limitation of hip motion and are used in the differentiation between low back and hip disorders. They are signs of the "low back-sciatic syndrome" rather than of hip disease and indicate spasm or contracture of the posterolateral fascia of the thigh. They do cause limitation of motion of the hip, however, and consequently produce characteristic changes in the graph.

In order to measure combined motions accurately, an arthrometer has been devised. (Fig. 2.) Without a mechanical aid, combined motion could not be accurately measured. This arthrometer is too cumbersome and complicated for routine clinical use, but it can be used in the more obscure cases and the facts gained from its use may aid the diagnosis in any case.

That this arthrometer accurately measures motion of the hip joint is demonstrated by these diagrams. (Fig. 3.) A protractor

placed opposite the head of the femur and moving in the anteroposterior plane obviously reflects this motion. Abduction

motion is being estimated. Milch<sup>5</sup> has discussed this recently. Motion of the pelvis can cause an apparent increase in

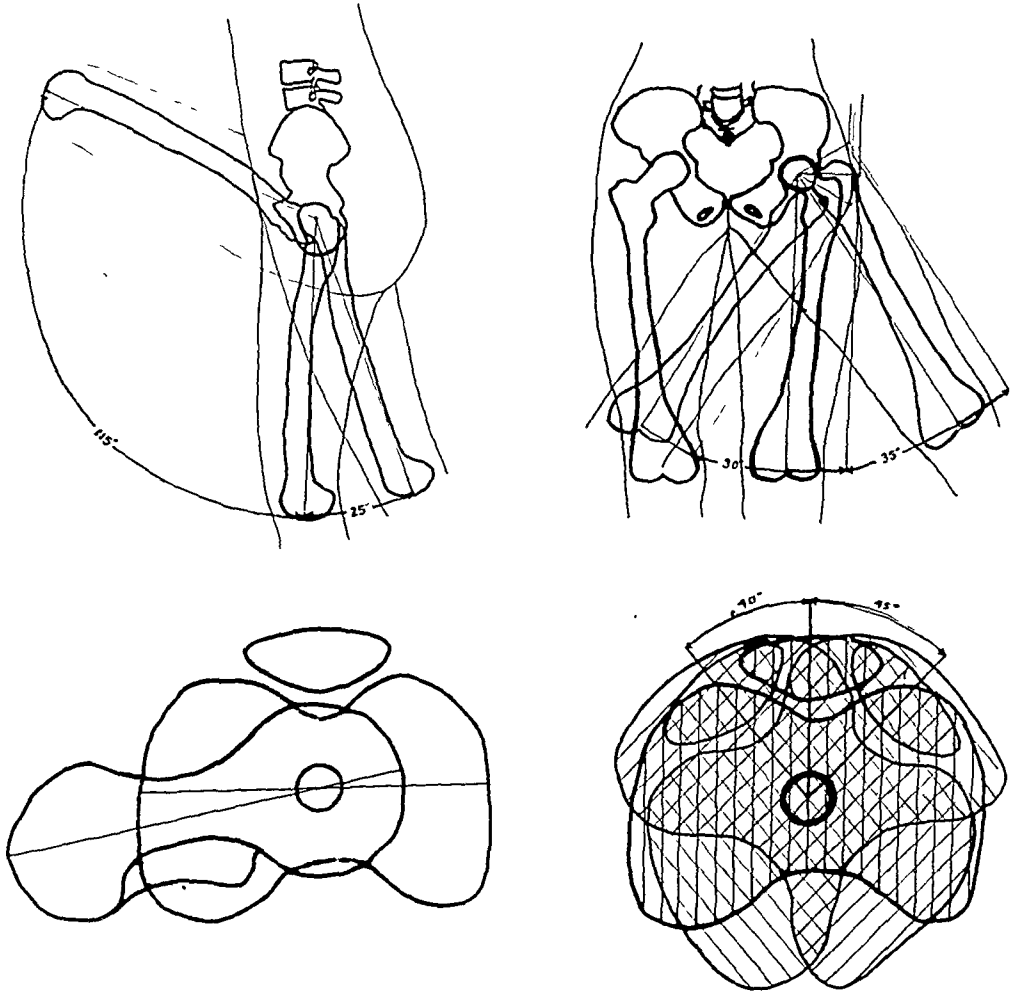


FIG. 3. Points of measurement. These charts are designed to show that the arthrometer accurately measures hip joint motion. Flexion and extension (upper left) are measured immediately lateral to the head of the femur. Abduction and adduction (upper right) are measured at this same point which necessarily moves up with abduction and down with adduction, maintaining the same position relative to the trochanter. Rotation (lower right and left) is measured on the femur, immediately above the knee, as rotation at this point is the same as rotation at the hip.

and adduction can be accurately measured at the same point. It is only necessary that the center of motion, by moving up and down, keep a fixed position relative to the trochanter. Rotation can be accurately measured at any point on the thigh as it moves as a whole. With this arthrometer, it is measured slightly above the knee.

All know, but sometimes forget, that pelvic motion must be prevented or at least it must be measured, when hip

range of all motions of the hip. Contact with the abdomen is also said to limit flexion of the hip, but it is our opinion that if the pelvis is not allowed to tilt, it is only in the very obese individual that this is true. It is also always necessary to remember that the hamstrings limit flexion of the hip when the knee is extended and the quadriceps limits extension of the hip when the knee is flexed. In addition, many careless and inaccurate statements

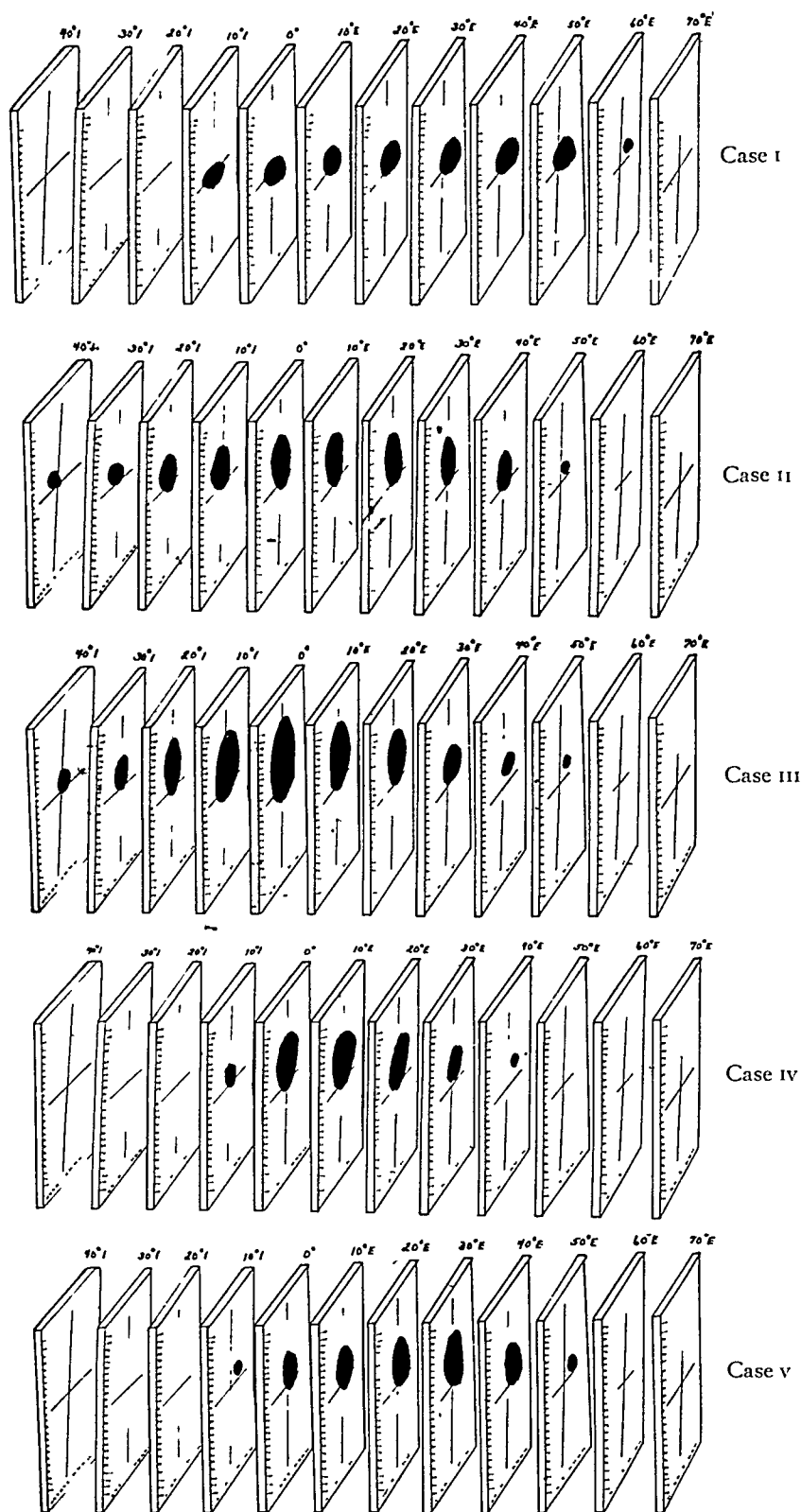


FIG. 4. Three-dimensional graph of reported cases.

are made regarding hip motion. For example, one text states that contact with the other thigh limits adduction. The other thigh should be moved out of the

way. Many other such examples could be cited.

So much for the general considerations of hip joint measurement. What factors determine motion? The bony configuration generally defines the range of motion, i.e., the size and shape of the acetabulum, the angle of the neck and shaft, its anteversion, etc. A very wide range of motion is possible when soft part limitation is not imposed. For example, in the dry skeleton, if the femur is highly abducted and externally rotated, the hip can be moved in the full arc of 360 degrees. It is quickly seen and can be forecast accurately according to mathematical formula what extensive changes in motion result from slight alterations in the angle between the neck and shaft of the femur and in the anteversion. Hypertrophy of cartilage, cartilaginous erosion, irritation, exostoses, etc., also affect motion. Soft part structures,

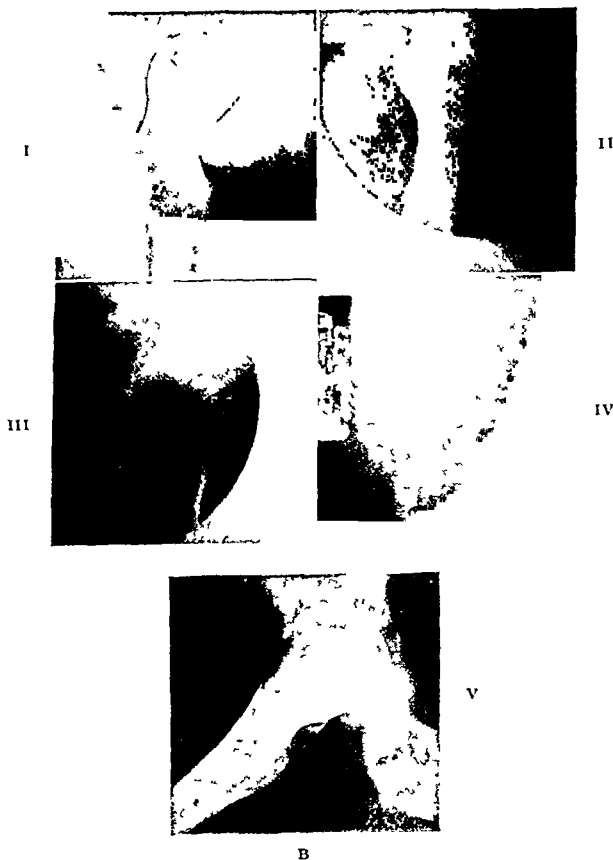
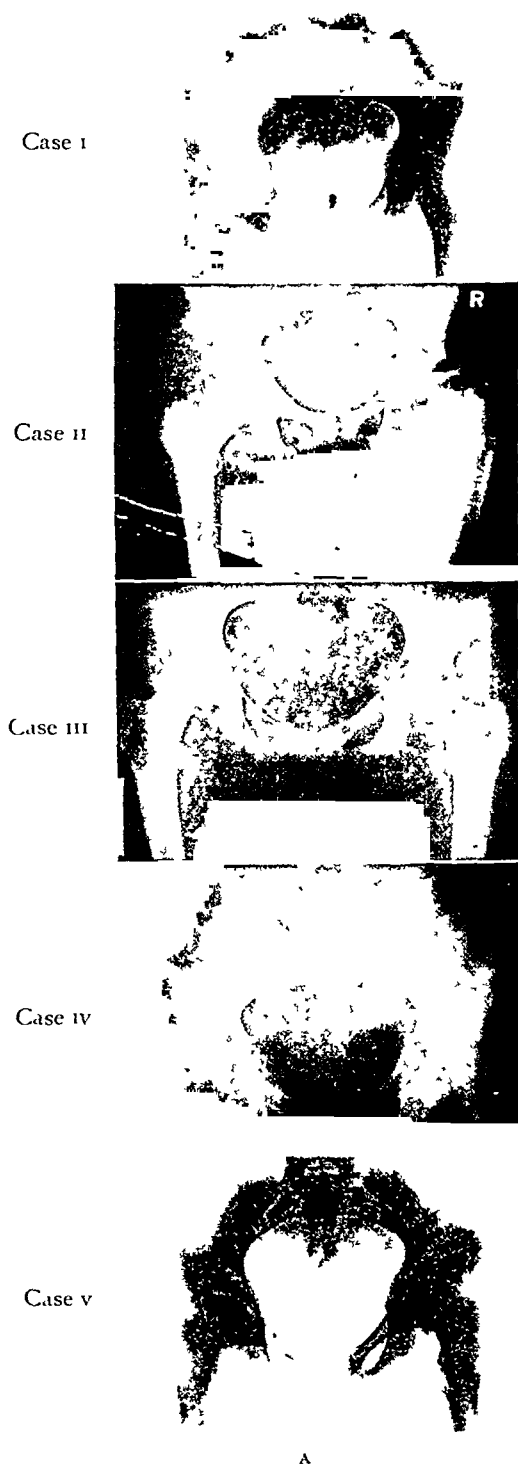


FIG. 5. A and B, x-rays of reported cases.

especially the capsule, are most important causes of limitation. A study was made of a cadaver specimen and the complete range of motion measured. It was found that the measurements coincide almost exactly with the normal living. This confirms the observation of Stassen as reported by Steindler.<sup>6</sup> Incidentally, Steindler, in his "Mechanics and Motion of Joints" offers an excellent discussion of joint motions, including the hip. Other soft parts, such as contracted and spastic muscles, fascial bands, etc., are common offenders in limiting hip motion. The muscles especially bear close study as they have very complex actions. Sometimes this action reverses itself as the thigh moves from complete extension to complete flexion. Interpretation of localized limitation of motion is made easier if this is remembered.

#### CASE REPORTS

CASE I. H. F., female, thirteen years of age, had an early posterior slipping of her upper femoral epiphysis. It was necessary to retouch the lateral view in order to demonstrate the neck and head of the femur, but the posterior slipping was easily seen. The three-dimensional graph of this case shows the limitation of internal rotation which is a mathematical necessity in this condition. When a posteriorly slipped head is internally rotated to its limit, the rotation of the shaft lags behind. Also, note the expected increase in external rotation, as in this motion the shaft precedes the head. Also note the increased abduction. This abnormal motion is thought to be a very important sign of this condition and sometimes it is found before x-ray changes are demonstrable.

CASE II. E. M., male, 18 years of age, had a marked hip deformity caused by a cyst in this region. The patient suffered from osteitis fibrosa disseminata and showed a cystic degeneration of other bones. This case is offered because it shows a remarkable range of motion in the presence of most extensive bony deformity. The expected decreased abduction and increased adduction is found.

CASE III. C. G., twenty-eight years of age, female, had a soft part infection about the left hip as a child, but now shows no symptoms.

X-rays show a slight lack of development of this side, but, generally they are not remarkable. In the routine examination of this case, the Patrick sign was found to be positive and one might conclude that the patient has some hip disorder which causes spasm or shortening of the adductor muscle group. However, if the complete range of motion is determined, it is found that while there is a decreased abduction and external rotation, there is an increased adduction and internal rotation. In short, the size and shape of the motion graph is normal, but it is simply shifted toward the adduction-internal rotation segment.

CASE IV. R. R., forty-seven years old, male, had a moderately severe malum coxa senilis. He had had symptoms for about five years and there was some erosion of cartilage and some lipping. The cubic graph shows not only Patrick's limitation of extension of the flexed, abducted and externally rotated hip, but a generalized limitation of motion. If an arthritis is sufficiently advanced to show in the x-ray, there will be a more extensive limitation of motion than that described by Patrick.

CASE V. E. R., nineteen years of age, male, had had pain in his hip for three years. The x-rays show some disturbance in the epiphyseal line. Before inspection of the lateral view, posterior slipping of the epiphysis would be suspected, but this latter shows no abnormality. The motion graph shows a marked limitation of extension and also internal rotation. This patient's age, the distorted epiphyseal line, the lack of changes within the joint itself allow this to be classified as an osteochondrosis. The extreme limitation of motion is probably due to changes in the cartilage and capsule.

Other studies have been made and it is expected that as many more are made, we can better interpret the meaning of abnormalities of hip motion.

In conclusion, we reiterate that accurate measurement of motions of the hip joint often is an aid to diagnosis of disorders here. We especially emphasize that complete delineation of the complex motions is necessary if motion may be said to have been determined accurately. We have demonstrated an arthrometer by which



one can accurately measure these motions and we show a three-dimensional graph by which we graphically chart them. We cite conditions in which an earlier or more accurate diagnosis is possible because of these measurements.

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IN avulsion or "duck-beak" fractures the fragment is drawn up by the attached Achilles tendon, and cannot be reduced or held by conservative treatment. A stainless steel screw is satisfactory for internal fixation; on account of its superficial position the screw must be removed three months later, after union has taken place. A shoe with a heel raised should be worn for the following two months, during which period physiotherapy may be necessary.

From "Fractures and Dislocations for Practitioners" by Edwin O. Geckeler (The Williams & Wilkins Company).

# BOWEL SURGERY\*

## IMPRESSIONS AFTER FIVE YEARS OF EXPERIENCE

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THE purpose of this communication is to transmit our impressions gained from a five-year study of surgery of the large bowel. Although the cases are varied (Table I), such a study must of statistical necessity be concerned mainly with cancer of the colon, which comprised 86 + per cent of all the cases tabulated.

The gastrointestinal service of the Jewish Hospital was organized in April, 1938. Since then its course has been similar to many beginning specialty services, slow to start, but gradually gaining momentum and finally becoming an accepted part of the surgical service. The gastrointestinal service, as its name implies, has within its scope all major intestinal surgery from the cardio-esophageal junction to the rectum, inclusive. This paper, however, concerns itself mainly with the large bowel. At the Jewish Hospital, the service has eight beds, the overflow going to general surgery. These eight beds have for the most part been filled in the past two and a half years. As a result, a unique opportunity has been granted to a small group of surgeons and the resident staff to study and familiarize themselves with the technics and problems of major bowel surgery. At the present writing, the resident staff performs practically all of the major and minor operative procedures. Technics have been standardized and although individual patient variation is taken into account, the service as it now functions represents an excellent source of material and training for our surgical residents.

Our patients derive from the medical wards, the clinic and the local physician. Very often as not, they are in a poor physi-

cal condition, emaciated, anemic, with associated complications of diabetes and arteriosclerotic heart disease. All of our patients are within the so-called carcinoma age group, namely forty to eighty years. In our series, the sexes are fairly equally divided except for the curious predominance of males (73 per cent) in the right colon group. However, due to the small number of cases, this probably is not statistically significant. The symptoms manifested have not varied from those usually associated with malignancy of the bowel. (Table II.) Upper abdominal, crampy pains were common in all groups, while blood in stools and constipation were present in a large number of lower left colon and rectal cases. Obstipation was most common in left colon cases. We have not noted alternating diarrhea and constipation in our right colon cases. Chronic obstruction due to the malignant disease is common, while acute obstructions, in our experience, have been predominantly in the left colon.

Despite current accepted teaching, the peripheral blood of our right colon cases showed no greater degree of anemia than the others, although the percentage of cases having anemia was greatest in this group. Assuming that a hemoglobin of 70 per cent or less and a red blood cell count of 3,500,000 or less represents a state of anemia, anemic states were found in the various groups as follows: right colon, 50 per cent; mid colon, 20 per cent; left colon, 42 per cent; rectum, 30 per cent. The most severe anemias were found in the rectal and right colon groups. All, however, except in the acutely obstructed

\* From the Gastrointestinal Service, Jewish Hospital of Brooklyn.

TABLE I

CASES WITH LESIONS IN LARGE BOWEL

(A) Benign lesions	
(1) Chronic ulcerative colitis	12
(2) Volvulus of Sigmoid	2
(3) Diverticulitis of Sigmoid	3
(4) Imperforate Anus	1
TOTAL	18
(B) Malignancy	
(1) Right Colon	22
(2) Mid Colon	10
(3) Left Colon	43
(4) Rectum	41
TOTAL	116

TABLE II

SYMPTOMS

	Right Colon	Mid Colon	Left Colon	Rectum
Abdominal discomfort	+	++	+++	+
Abdominal cramps	+	++	+++	+
Change in bowel habits	+	++	+++	++++
Blood in stool				
Occult	++++	++	+	+
Visible	±	+	+	++++
Anemia	50%	20%	42%	30%
Hgb 70 %	of	of	of	of
RBC 3,500,000	cases	cases	cases	cases
Evidence of Obstruction	+	+	+++	++ Recto- sigmoid
Hypertension	21%	25%	32%	41 %
Systolic 150				
Diastolic 90				
Fatigue	+++	++	+	++
Anorexia	+++	++	++	+
Weight loss	+++	++	++	+

phase, manifested more or less peripheral anemia depending on the length of the disease and its spread. Systolic and diastolic pressures, as tabulated in this series, were lower in the right colon cases and higher in the left colon and rectal cases. Hypertension was very common in the left colon group. Assuming that hypertension is present when the systolic pressure is recorded as 150 mm. or higher, and diastolic pressure as 90 mm. or higher, hypertensive states were found in the various groups as follows: right colon, 21 per cent; mid colon, 25 per cent; left colon, 32 per cent; and rectum, 41 per cent. We have no explanation for this phenomenon, since age, sex and associated degenerative diseases were approximately the same in all groups.

Diagnosis rested on symptomatology, contrast enema and sigmoidoscopy. X-ray studies of colon lesions by barium meal, especially in cases of chronic or subacute obstruction, very often ended disastrously, because acute intestinal obstruction supervened. These patients in most instances did not respond well to surgical therapy. We have noted some difficulty in x-ray interpretations of cecal lesions. If any doubt exists and the symptomatology points to a malignant cecal lesion, we now prefer to explore; having found that much valuable time was lost in repeat x-rays from both below and above, which, in the end, were still inconclusive. Of interest is the fact that a number of cecal lesions in which the x-ray diagnosis was in doubt were found at operation to be instances of segmental non-specific colitis grossly limited to the cecum.

Any discussion of operability (resectability) must necessarily concern itself with the mode of malignant spread. Local lymphatic spread, if confined to the mesentery, is amenable to total extirpation. Spread into the more distant nodes, periaortic, etc., has been no contraindication to radical resection. At times it has been difficult to differentiate between inflammatory and malignant involvement

of the nodes. Since, however, the combination of other factors besides lymphatic spread have influenced our criteria of operability, this differentiation is not as important surgically as it may be pathologically. Spread by contiguity is similarly amenable to surgery if vital structures are not involved. Contiguous invaded bowel has been resected, as have portions of the anterior abdominal wall. Bladder has not been resected, but shaved closely. Vascular metastases, as evidenced in the liver, have caused some concern. Two or three isolated metastatic deposits in the liver have been no bar to radical resection, since patients in this state have lived two or three years after resection. We have not resected involved portions of liver, although in the future, if we find a single isolated metastasis, we plan to do so. In rectal carcinomas, the radical abdominoperineal amputation was performed despite isolated liver metastases, if other conditions were favorable, especially since the mortality was not influenced by these metastases and the patient's subsequent life was rendered more comfortable. Our limits of operability have been extended to the point that only if the bowel is frozen, or the liver studded, is a palliative operation performed. As is seen in our cases (Table III), lymphatic metastases (44 to 68 per cent) rank high in all groups of colon cases, while vascular metastases vary from 22 to 29 per cent in the respective groups. It should be understood that these percentages are derived from our operative findings as contrasted to pathological studies reported in the literature. Vascular metastases are common in all but the mid-colon group, but the small number of cases negates the importance of this finding. Curiously, the mid-colon and rectum most often presented no evidence of any of the three types of metastatic spread. It should be stated that although the presence of distant metastases, especially in the liver, precludes hope of cure, resection of the local growth is most often followed by a

gain in weight and well being. Death due to a liver studded with metastases is kinder to the patient than death from a

sion, utilizing the Miller-Abbott tube. Passage of this tube through the pylorus in the acutely obstructed cases is difficult.

TABLE III  
OPERATIVE EVIDENCES OF MALIGNANT SPREAD  
(Percentage of Cases)

	<u>Right Colon</u>	<u>Mid Colon</u>	<u>Left Colon</u>	<u>Rectum</u>
Lymphatic	68 %	60 %	44 %	56 %
Vascular	22	0	23	29
Contiguous	55	20	54	41
None	9	20	9	34
OPERABILITY	54.5%	90%	70%	59%

perforation of an ulcerating mass with generalized peritonitis.

Arbitrary classification of the ninety-eight resected tumors according to the classification of Broders merely points to the fact that most tumors belong to groups 2 or 3. In the main, pathological grouping has not affected operability.

Of great importance in the determination of operability is the presence or absence

Even after passage into the small bowel, it is ineffective if the ileocecal valve is competent, therefore, rendering the large bowel a closed loop. Time is a factor in relieving the obstruction, especially in view of pending perforation. It has been our practice to perform tube cecostomy rather than transverse colostomy because of the relatively minor trauma of the procedure.

TABLE IV  
INCIDENCE OF OBSTRUCTION

	<u>Right Colon</u>	<u>Mid Colon</u>	<u>Left Colon</u>	<u>Rectum</u>
No Obstruction	12	5	20	34
Acute Obstruction	0	1	8	1
Subacute Obstruction	7	4	12	4
Chronic Obstruction	3	0	3	2
TOTAL	22	10	43	41

of obstruction. (Table iv.) The deaths from acute obstruction occurred solely in those patients with obstruction in the left colon, mainly in the splenic flexure. In this latter group, patients generally came in with marked obstructive symptoms of four to eight days and died of generalized peritonitis even though minor decompressive procedures (cecstomy) were resorted to. We have not been successful in the acute cases with medical decompres-

We have been greatly impressed with results of the management of the subacutely obstructed cases. These cases have been decompressed medically and clinically improved so that obstructive symptoms no longer became manifest. If at operation in these cases, dilated loops of bowel were seen, and radical resection attempted, the mortality was high and the convalescence very stormy. We have learned to perform minor preliminary

decompressive procedures rather than immediate radical resection in these cases.

From what has been said it appears quite evident that operability for the most part depends on whether or not the patient is obstructed and what the intra-abdominal findings are. The general condition and the associated diseases which the patient may have, are not deterrents to operation (except, of course, a moribund state). It does not follow, however, that we disregard the general state of the patient. It is a matter of common sense that a patient, debilitated and anemic, rendered more or less cachectic from harboring a malignant disease for some time, stands operation very poorly. This is especially true if associated hypertensive, arteriosclerotic, cardiac and diabetic states are present. With this in mind, therefore, we attach great importance to the meticulous preoperative care of the patient. The clinical, physical and mental components are given equal care. Anemia and low serum protein values in our experience have resulted in operative shock and a stormy postoperative convalescence in which the complications of poor wound healing and wound dehiscence were attended by a high mortality.

#### PREOPERATIVE CARE

Preoperative blood transfusions to elevate the blood level to at least 70 per cent hemoglobin are resorted to, while plasma transfusions, parenteral amino acids and additional protein feedings are similarly used to elevate the serum protein to a minimum level of 6 Gm. per 100 cc. Significant low blood chloride levels are found in obstructed cases associated with vomiting. Parenteral saline solutions and enteric coated salt capsules given in adequate amounts and carefully checked by frequent blood levels, quickly bring these levels back to the accepted normal of about 360 mg. per cent of chloride. Liver function tests are utilized whenever indicated, but curiously enough, gross aberra-

tions of liver function in malignancy were not present except terminally. Estimation of blood sugar values is routinely performed in all patients. Several times we have discovered diabetes in patients in whom the condition was totally unsuspected. Great attention is paid to blood urea nitrogen and non-protein nitrogen values, especially since these are prone to be elevated in the age groups associated with large bowel cancer. We have not infrequently seen patients with subacute or chronic obstruction, whose blood urea nitrogen levels approached normal after careful attention to the correction of anemia and the palliative or preliminary decompressive procedures. An elevated urea nitrogen which does not fall preoperatively is not a contraindication to operation, but we know that a stormy postoperative course will result. Prostatic hypertrophy with chronic urinary obstruction is looked for, and if found, a staged or transurethral prostatic resection is performed before major bowel surgery is resorted to.

A high caloric, high vitamin, low residue diet is given to our colon cases. Attention is given not only to the dietary regulation of diabetics so that from 0.4 to 1 per cent [ $+$  to  $++$ ] of sugar is routinely found in the urine, but actually to feeding them a truly high caloric diet, although this may require a higher daily insulin dosage. We do not endeavor to render a patient completely sugar free. Thiamin chloride, 10 mg. and vitamin c, 500 mg. daily, are routinely given, either by mouth or parenterally. Liver, iron and B<sub>1</sub> complex are given when indicated. Since diet restriction is common in this group of patients, subclinical vitamin deficiencies are also present. In view of this, the high daily vitamin dosages seemed to us to be of value. Certainly we have seen no harm from these large doses.

Like other clinics, we have run the gamut of methods of bowel cleansing in attempts to reduce the bacterial flora and fauna of the intestinal tract in uncomplicated cases. At the outset, we resorted to purga-

tion and colon cleansing by enemas and irrigations. Following this, sulfaguanidine and then sulfasuxidine were used. Our procedure at present consists of preliminary purgation with epsom salts followed by the daily administration of succinyl-sulfathiazole in divided doses approximating  $\frac{1}{4}$  Gm. per Kg. of body weight per twenty-four hours. No mechanical cleansing of the bowel is performed. Statistically we have noted no essential difference in the rate of wound infection or peritonitis, whatever the chemical preparation has been. It is our impression, however, that although wound infection may be the same, serious intra-abdominal and intramural infections are not only less common, but appear to be less vicious and overwhelming. Preoperative use at first of sulfanilamide and later of sulfadiazine yielded no significant decrease in infections, so that we have ceased their use preoperatively. Interestingly enough, in a number of cases premedicated with either of these two drugs, the procaine continuous spinal anesthesia was not effective in the usual doses or was completely ineffective. The neutralizing qualities of procaine (of the para amino benzoic acid group) on the sulfa derivatives is well known. Since both sulfanilamide and sulfadiazine pass freely into the spinal fluid, it is conceivable that a sufficient concentration may have been present to cause the reverse effect, that is, the effective biochemical neutralization of procaine with resultant loss of the anesthetic properties of procaine. This is now the subject of an independent investigation.

The problem of operative and postoperative shock concerned us, as it did anyone who dealt with major bowel surgery. With the advent of cortical extract, cortate with salt was given routinely. Shock did occur, although it may be said, less severely. However, shock was frequent enough to indicate that cortical extract was not the only factor. Of late, shock has been rare in our series. This is attributed to the liberal use of whole blood. Almost routinely now, 1,000 cc. of blood are given

during and immediately after operation. In those patients with severe cardiac damage whose parenteral fluid intake must of necessity be limited, whole blood was given in lieu of saline and the amount of parenteral saline administered is considerably reduced over and above the amount usually administered to this type of patient. To rehabilitate most patients with respect to the criteria described above it takes from five to seven days in the average case. Some patients, however, may take weeks to approach a clinical state in which operation may be reasonably safe.

In view of our meticulous preoperative rehabilitation of the patient, we believe that in most cases a one-stage procedure is justified. Stage procedures are resorted to only because of obstruction, local mechanical difficulties (obesity, etc.), local perforations, or lack of improvement after the preoperative measures outlined above.

Anesthesia has been individualized for each case. All cases have been seen by our physician anesthetists who prescribe the premedication and choice of anesthetic agent. However, whenever possible, spinal anesthesia has been utilized. For the past year and a half, fractional procaine spinal anesthesia has been used. The abdominal and visceral relaxation, the contracted quiescent bowel and the ease of manipulation not only saves time but allows for a direct approach with minimal manipulation and resultant decreased operative shock. Fractional spinal with cautiously administered small doses has further extended the advantages and usefulness of this admirable mode of anesthesia. In severe cardiacs, and very poor risk patients, ether with intratracheal intubation is frequently resorted to. Cecostomies are performed under local novocaine infiltration anesthesia. Colostomy closures are routinely performed under inhalation anesthesia, since the cleanliness of even the posterior spinal region is always suspect in the presence of an open functioning colostomy.

RIGHT COLON

The operation of choice is the one-stage right hemi-colectomy with an ileotrans-

three in the hepatic flexure. Five one-stage hemi-colectomies with ileotransverse colostomy were performed with one death,

TABLE V  
MANAGEMENT OF RIGHT COLON LESIONS

	Cases	Deaths
One Stage Resection with Immediate Anastomosis	5	1
Two Stage Anastomosis and Delayed Resection	1	1
Lahey Right Hemicolectomy - Delayed Anastomosis	7	1
Ileo-transverse Colostomy	3	3
Cecostomy	1	0
Inoperable	5	0
TOTAL	22	6

Operable Cases

12

Operability

54.5 %

verse colostomy end-to-side. (Table v.) We prefer the aseptic closed anastomosis, using the Furniss clamp. In point of time, the ileotransverse colostomy is done early during the operation and if the condition of the patient permits, the resection then follows. If the structures are fixed, a two-stage procedure is performed. Small bowel dilatation due to colon obstruction in which the performance of an ileotransverse colostomy would appear hazardous because of possible leakage, is an indication to us for a Lahey right hemi-colectomy. We also utilize the exteriorization operation on the right side when we are pressed for operative time, for one reason or another. Since it is in effect an ileostomy, chlorides and serum proteins soon acquire a very low blood level. Close attention to replenishing chlorides with physiologic saline and proteins by frequent blood and plasma transfusions is required before the ileostomy becomes equilibrated to the body economy. Cachexia, emaciation, hypochloremia and dehydration are common before this occurs.

Twenty-two patients with pathological conditions of the right colon pathology were treated. Of these, twelve were in the cecum, seven in the ascending colon and

a mortality of 20 per cent. Seven Lahey right hemi-colectomy procedures were performed, with one death,—a mortality of 14 per cent. Because of fixation, three had preliminary ileocolostomy with a mortality of 100 per cent. One died at the completion of the second stage of the two-stage procedure. Five were deemed totally inoperable and one had a cecostomy for a hepatic flexure lesion with diffuse metastases. Total operable cases numbered twelve, with an operability rate of 54.5 per cent.

*Tabulation of Deaths (Right Colon).* 1. Death occurred in a fifty-nine year old male with an ascending colon lesion, fixed. A preliminary ileotransverse colostomy, open, side-to-side, was performed. Postoperatively the patient developed bronchopneumonia, culturing pneumococcus type xix. Subcutaneous wound dehiscence occurred on the seventh day and death on the eleventh day. No autopsy was performed.

2. A sixty-two year old male, emaciated and chronically obstructed, with a cecal malignancy which appeared fixed, had an ileotransverse colostomy, open, end-to-side, performed. No resection was performed. He developed diffuse bronchopneumonia on the third postoperative day. The patient had a marked fascial slough and wound infection from which hemolytic streptococci were cul-



tured, both aerobically and anaerobically. Sulfanilamide clyses were given and wound dehiscence followed. The patient died on the fifth postoperative day and necropsy showed purulent peritonitis.

3. A seventy-one year old male with a hepatic flexure lesion, came in with marked nutritional edema and chronic obstruction. He had had an excision of a carcinoma of the sigmoid with end-to-end anastomosis twelve years previously. A Lahey right hemi-colectomy was performed. On the sixth postoperative day wound dehiscence occurred and on the tenth postoperative day a pulmonary infarct. Necropsy revealed that death was due to pulmonary embolization.

4. A fifty-nine year old female with a cecal lesion, chronically obstructed had a first-stage ileocolostomy. The tumor was fixed posterolaterally. A right hemi-colectomy was performed three weeks later. The patient was given sulfanilamide parenterally and also transfusions. Nausea and vomiting occurred on the fourth postoperative day and were treated with Levine tube and continuous suction. This patient presented a picture of progressive peritonitis and died on the ninth postoperative day. No autopsy was performed.

5. A fifty-eight year old female, obese and diabetic, with chronic intestinal obstruction, had an ileotransverse colostomy performed without resection. Wound infection occurred on the seventh postoperative day accompanied by fascial slough and bronchopneumonia developed on the twelfth postoperative day. This patient had marked hypoproteinemia. Anuria appeared on the eighteenth postoperative day and death occurred on the twenty-sixth postoperative day due to uremia. Necropsy revealed shrunken kidneys and bronchopneumonia.

6. A fifty-five year old male with a hepatic flexure lesion, had a resection done with end-to-side ileotransverse colostomy. This patient developed vomiting and distention on the third postoperative day, shock on the fourth postoperative day and died six days after operation in shock. Necropsy showed that the inverted stump of the transverse colon was edematous and sat on the ileotransverse colostomy stoma, effectively plugging it and causing obstruction. Although obstructive symptoms were present, symptoms of shock and vasomotor collapse predominated. This case represented a surgical error in bringing the

ileotransverse colostomy too close to the inverted transverse colon stump.

#### MID-COLON

The operation of choice was a Rankin obstructive resection with extirpation of all involved mesentery, insofar as possible. Ten patients were treated, nine of which were resectable with no mortality. A loop colostomy was performed in the tenth case because of peritonitis due to a perforated neoplasm with hepatic and generalized peritoneal metastases, operability was 90 per cent, mortality 10 per cent. (Table VI.)

Although the exteriorization operation has been the operation of choice, we have always feared the crushing of the spur because of the proximity of the lower portion of the spur to the root of the mesentery of the small bowel. For that reason, we believe that in the future, the operation of choice will be a resection and immediate establishment of alimentary continuity with or without preliminary cecostomy.

*Tabulation of Deaths—Mid-colon.* A sixty-four year old male, emaciated, with signs of spreading peritonitis, showed diffuse generalized peritonitis at operation resulting from a perforated fixed neoplasm of the mid-transverse colon. Hepatic and generalized peritoneal metastases were present. A rubber tube was inserted into the perforation and the abdomen closed. He died of generalized peritonitis on the fourth postoperative day. No necropsy was performed.

#### CARCINOMA OF LEFT COLON

The Rankin obstructive resection method with delayed establishment of alimentary continuity is favored. A moderate degree of obstruction of a chronic nature has usually been found. This did not preclude the use of the Rankin procedure since vent is given to the proximal obstructed loop in 24 hours by means of a fine catheter inserted proximal to the clamp. (Table VII.)

There were forty-three cases, nine of the splenic flexure, eight of the descending colon and twenty-six of the sigmoid. Thirty were operable with an operability of 70

per cent. Of these, three patients (10 per cent) died. Twelve were inoperable either by virtue of acute obstruction (8) or

2. In a twenty-seven year old poorly nourished female, thought to have endometriosis with crampy lower abdominal pains and right

TABLE VI  
MANAGEMENT OF MID COLON LESIONS

	Cases	Deaths
Loop Colostomy	1	1
Rankin Obstructive Resection	9	0
TOTAL	10	1
Operable Cases	9	
Operability	90 %	

because of diffuse vascular and peritoneal metastases. In this group, five died with a mortality of 41.5 per cent. The final case was an error in diagnosis. She was thought to have endometriosis and had an excision of part of ileum with a double-barrelled ileostomy resulting. The patient died in shock on the second postoperative day and at postmortem was found to have car-

upper quadrant mass of one month's duration, tumor masses were found throughout the bowel at a previous exploratory operation. One was resected and reported as granulation tissue with inflammatory reaction. A resection of the obstructive segment of the ileum was performed with a double-barrelled ileostomy. The patient went into shock during the procedure, which lasted forty-five minutes, but rapidly responded to the usual measures. She

TABLE VII  
MANAGEMENT OF LEFT COLON LESIONS

	Cases	Deaths
Rankin Obstructive Resection	30	3
Ileostomy	1	1
Cecostomy	8	4
Transverse Colostomy	4	1
TOTAL	43	9
Operable Cases	30	
Operability	70 %	

cinoma of the sigmoid with diffuse peritoneal metastases [see case #2].

*Tabulation of Deaths—Left Colon.* 1. A forty-nine year old female, jaundiced, with myocardial involvement, hypertension and diabetes, was treated with parenteral glucose solutions and insulin. Her jaundice subsided and her diabetes was controlled. The Rankin obstructive procedure was performed, but bronchopneumonia developed on the fourth postoperative day due to pneumococcus type III. She died on the seventh postoperative day. No autopsy was performed.

sank into a shock state again after a few hours and did not rally. Postmortem examination showed diffuse carcinomatosis with the original site in the sigmoid.

3. A forty-five year old, poorly nourished male with acute intestinal obstruction, not relieved by Miller-Abbott tube or Levine tube with continuous gastric suction had a cecostomy performed under local anesthesia. There was a perforated lesion of the splenic flexure. The peritoneal cavity cultured hemolytic streptococci. The patient had persistent distention with signs of generalized peritonitis

and died on the thirteenth postoperative day. No autopsy was performed.

4. A fifty year old obese female with acute obstruction, presented a firm indurated mass in the sigmoid region thought to be perforating carcinoma or diverticulitis. A loop transverse colostomy was performed. Operative shock took place from which she recovered. Eight hours or so after operation, a vesico-abdominal fistula was noted. She died during transfusion on the first postoperative day. A check of blood grouping revealed no incompatibility. No autopsy was performed.

5. A seventy-nine year old male, acutely obstructed, not relieved by usual decompressive measures, had a cecostomy performed under local anesthesia. No operative shock took place. He died on the first postoperative day. Postmortem showed a perforated splenic flexure lesion with diffuse peritonitis.

6. A fifty-six year old, emaciated male with carcinoma of sigmoid, had the Rankin obstructive procedure performed. Bronchopneumonia developed on the fourth postoperative day, which was treated with sulfapyridine. The patient died on the fifth postoperative day. Postmortem showed diffuse bronchopneumonia, the peritoneum was clean.

7. A sixty-seven year old female, emaciated, distended and dehydrated, had her distention relieved by the usual decompressive measures. A Rankin obstructive procedure was performed for descending colon carcinoma. Fascial slough occurred on the seventh postoperative day complicating wound infection; a decubitus ulcer over sacrum appeared and the patient died on the twenty-third postoperative day. Postmortem revealed bronchopneumonia, arteriosclerotic heart disease and arteriosclerotic kidneys.

8. A sixty-one year old male obstructed and emaciated, had the usual decompressive measures taken to no avail. Cecostomy was performed under local anesthesia, but shock intervened on the third postoperative day followed by congestive failure and death. No autopsy was performed.

9. A sixty-seven year old female, who entered with tight abdominal distention and obstipation of one week, had a cecostomy performed under local anesthesia. Cardiac decomposition occurred on the first postoperative day and bronchopneumonia on the second postoperative day. There was evidence of overwhelming peritonitis which did not

respond to parenteral sulfadiazine and cautiously administered blood and plasma. She died on the eleventh postoperative day. No autopsy was performed. Wound inspection revealed perforated carcinoma of the splenic flexure with diffuse peritonitis.

#### CARCINOMA OF RECTUM

The operation of choice is the one-stage combined abdominoperineal amputation of Miles. (Table VIII.) The artificial anus is brought out in the left paramedian incision which is used for the exploration. We have ceased using the stab wound for the terminal colostomy and we do not close the left paracolic gutter.

The Lahey staged operation was performed when the pelvis contained numerous adhesions to small bowel or if the pelvis was the site of inflammation and when it was believed that a preliminary colostomy procedure would allow for a subsidence of the inflammatory process. It was also used in those cases in which it was believed after exploration of the peritoneal cavity that the patient offered too many mechanical difficulties, making a one-stage procedure hazardous.

Terminal colostomies are opened in twenty-four hours and a rectal tube is cautiously passed two to three times daily to release gas trapped in the proximal sigmoid and descending colon.

The cavity left in the perineal wound is filled with a Mickulicz rubber dam in which a roll of gauze is inserted. The skin edges are partly closed with sutures. The gauze is partly removed on the third postoperative day and completely removed with the rubber tissue on the following day. Irrigation is started on the fifth postoperative day and continued for about a week.

This group comprised thirty-nine rectal and two anal cases. Eighteen patients were subjected to a one-stage combined abdominoperineal amputation with one death. Ten cases had a first-stage Lahey procedure. Of these, only five returned for the completion of the second stage, with three deaths. Eleven patients were deemed inoperable and had palliative colostomies

with one death. Of the two anal cases, one second-stage Lahey performed. Tense distention and high temperature developed on the second postoperative day, and the patient

TABLE VIII  
MANAGEMENT OF RECTAL AND ANAL LESIONS

	Cases	Deaths
Combined Abdomino-perineal Amputation One Stage (Miles)	18	1
Combined Abdomino-perineal Amputation Two Stage		
a) Lahey Procedure - 1st stage	10	0
2nd stage	5	3
b) Lockhart-Mummery	1	1
Local Excision of Anal Lesion	1	0
Palliative Colostomy	11	1
TOTAL	41	6
Operable Cases	12	
Operability	59%	

second stage of the Lockhart-Mummery two-stage procedure. Of this entire group, twenty-four patients were operable, yielding an operability rate of 59 per cent.

*Tabulation of Deaths—Rectum and Anus.* 1. A fifty-nine year old woman in good condition, had had a first-stage Lahey procedure two months previously, then a second-stage Lahey with resection of the coccyx. She died of purulent meningitis on the eighth postoperative day. Necropsy showed purulent meningitis.

2. A fifty-nine year old female who previously had a loop colostomy for carcinoma of the lower rectum followed in three weeks by an anal resection (Lockhart-Mummery), developed septic thrombophlebitis on the eighth postoperative day; on the twenty-second postoperative day, pulmonary infarct and died on the thirty-first postoperative day of cardiac failure. Necropsy showed generalized peritonitis.

3. A sixty-six year old female who had immediate postoperative confusion after a second-stage Lahey operation, developed wound dehiscence on the sixth post-operative day. From the seventh to fourteenth postoperative day, mental confusion and thrombophlebitis of wrist and arm appeared with sudden pulmonary edema and death on the fourteenth postoperative day. No autopsy was performed.

4. A forty-eight year old male, had a

died on the third postoperative day. Necropsy showed necrosis of the pelvic floor and of urethra, generalized peritonitis and adhesion of the loop of ileum to the pelvic floor.

5. A seventy-three year old male, chronically ill and emaciated, had the small bowel fixed in a frozen pelvis. Loop sigmoidostomy was performed. Postoperative bronchopneumonia developed and was treated with sulfapyridine. Evisceration occurred on the tenth postoperative day, peritonitis on the eleventh postoperative day due to retraction of sigmoidostomy, and the patient died on the twenty-fourth postoperative day. No autopsy was performed.

6. A forty-nine year old male, poorly nourished, had an abdominoperineal amputation performed. On the fourteenth postoperative day, abdominal cramps developed into acute intestinal obstruction in which the usual decompressive measures were of no avail. He died in vasomotor collapse on the eighteenth postoperative day. Necropsy showed generalized peritonitis.

#### POSTOPERATIVE TREATMENT

Postoperative treatment was in reality a continuation of our preoperative care with attention to specific postoperative complications.

In view of the frequent complication of gastric and small bowel ileus following

major bowel surgery, we have learned routinely to aspirate the stomach several times daily and not wait until vomiting supervenes. We do not utilize continuous gastric syphonage with a Wangenstein apparatus.

Postoperative pulmonary complications were frequent regardless of the type of anesthesia used. Since the advent of potent sulfa therapy, however, bronchopneumonia appears to have been less lethal and more amenable to therapy. At present, our reliance on sulfadiazine, given orally or parenterally, appears to be justified in view of the benign course taken by many of these cases. Partial atelectasis occurred frequently (10 per cent). In the colon group, this state resolved itself spontaneously without resort to bronchoscopy in contradistinction to our gastric cases.

Cardiac complications are frequent as might be expected in this age group. Careful preoperative evaluation of the cardiac status by electrocardiographic studies, a careful history and physical examination, venous pressures and sedimentation rates have enabled us to anticipate to some degree the acute cardiac decompensation states which occurred. Careful preoperative digitalization of chronic cardiacs was resorted to. Postoperatively, cautious administration of fluids, occasionally in conjunction with diuretics, has enabled us to bridge the first two or three hazardous postoperative days. We routinely use intranasal oxygen postoperatively and avoid the depressing action on respiration caused by the excessive use of narcotics.

Wound infections do occur despite chemical treatment of the bowel and local use of crystalline sulfanilamide. Nevertheless, these for the most part have been benign and have not influenced the postoperative course to any great extent. Attempts to minimize infection are accomplished by: (1) Effective walling off of the skin from the subcutaneous tissues; (2) gentle handling of tissues; (3) aseptic anastomoses wherever possible; (4) local sulfanilamide implantation both in the peritoneal cavity and in the wound; (5) ablation of the

exteriorized segment of bowel in obstructive resections only after the abdominal wound is closed and the incision completely covered over; (6) frequent change of gloves, especially after manipulating the infected bowel; (7) counterdrainage of retroperitoneal spaces which may become infected, and (8) meticulous hemostasis.

Wounds which manifest subcutaneous infection are opened and allowed to granulate from the fascia upward.

Fascial sloughs have occurred with dehiscence as an infrequent, but distressing, phenomenon. All wounds in this series were closed with catgut. Of late, we have been using Deknatel silk No. 1 for our fascial closures with very satisfactory results. We have not as yet used wire. Dehiscence in our experience occurs despite strong silk stay sutures. Wound dehiscence is not treated by secondary suture. The wound is opened on the slightest suspicion of serosanguineous fluid drainage and after the sterile gloved hand can feel a subcutaneous hiatus. The bowel is depressed below the peritoneal level by strips of iodoform gauze which are placed in sufficient quantity to bring the packing mass up to the skin level. The skin edges are then taped together with adhesive and a broad adhesive corset is placed completely around the patient. Low serum proteins are fortified in the usual fashion with blood and plasma transfusions and with parenteral amino acids. The packing is gradually removed after a week and the wound is allowed to granulate from below. Curious to relate, we have seen few hernias or evidences of intestinal obstruction after this procedure.

We prefer intermittent catheterization for all our bowel cases except abdominoperineal amputations in whom we leave an indwelling catheter for two to three days after which we again employ intermittent catheterization. We do not employ tidal drainage since it has been our experience that vesical tone was re-established in all but one case during the patients' hospital stay. A few cases of urinary retention were found to be due to prostatic hypertrophy.

These were subsequently treated by prostatic resection. Cystitis is treated by bladder irrigations of silver nitrate and by low doses of the sulfa drugs, depending upon the causative organism.

The local treatment of skin excoriation in ileostomies and Lahey right hemicolectomies has constituted a vexing problem. Excoriation of the skin is the rule in these cases and can be prevented or minimized only by measures which tend to keep the offending ileal fluid from the skin. Careful drying, kaolin and powdered egg white, aluminum paste and nail polish are among the many measures which may help. Constant suction may be successful, while as a last resort, at times, raw meat slices or chopped meat with kaolin may clear the excoriation by a process of selective digestion. When the patient is able to tend to the dressing himself and to keep his skin dry, the excoriations clear up most rapidly.

Since we routinely allow our colostomy stumps to project at least an inch above the skin level, without tension, we have not been bothered with stump retraction except in two instances, one of which resulted in a mural infection without peritonitis. The other, as described elsewhere, occurred in a loop sigmoidostomy in which dehiscence allowed retraction of the colostomy below the peritoneal level with peritonitis and death resulted. Terminal colostomies in abdominoperineal amputations are cut off at least 2 inches above skin level. Despite this, we have had two instances of slow postoperative retraction necessitating plastic procedures to bring the skin down to the colostomy level in order to avoid the resulting crippling stricture of the colostomy stoma. We have had two cases in which the fascial sutures were placed too close to the colostomy stump, cutting into it with resultant fecal leakage into the wound.

Needless to say, despite his apparent intelligence, the less said to the patient about the pathological condition and the duration of the colostomy, the better.

## CONCLUSIONS

1. Good results in bowel surgery depend on careful preoperative and postoperative care, and attention to details which in most instances can be carried out only by a well trained and experienced resident house staff.

2. We have found hypertension in a large percentage of our left colon cases.

3. Anemia was most severe in our rectal and right colon malignancies.

4. X-ray visualization of cecal lesions is often unsatisfactory.

5. Discovery of cecal disorders at operation is not infrequent after negative roentgenograms.

6. Vascular metastatic malignant spread is more common than reported in the literature.

7. The extent of operability can be increased by meticulous preoperative care of the patient. The true gauge of operability, however, depends entirely upon the individual intra-abdominal findings at operation.

8. The Miller-Abbott tube has been of no value in acute colon obstructions. It has been of some value in the subacute and chronically obstructed cases.

9. The more extensive the operative procedure is in the presence of obstruction, the higher the mortality.

10. Our experiences have led us to choose: (1) In right colon growths, anastomosis and immediate resection. (2) in mid-colon growths, resection and immediate anastomosis. (3) in left colon growths, obstructive resections with delayed anastomosis; and (4) in rectal cases, one-stage combined abdominoperineal amputations.

11. Chemotherapy appears to have decreased the virulence, but not the incidence, of wound and intraperitoneal infections.

12. The liberal use of whole blood appears to be the most important factor in the prevention of operative and postoperative shock.

13. Low serum proteins must be rigorously corrected if bowel surgery is to be successful.

14. Conservative treatment of wound dehiscence yields satisfactory results.

# AMBULATORY TREATMENT OF FRACTURES OF THE LOWER EXTREMITIES

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IN the ambulatory treatment of fractures of the lower extremities, after the fracture has been reduced and the limb immobilized, the patient should be allowed to leave the bed as soon as possible. Getting out of bed is the first and most important part of the treatment. Walking is of secondary importance, and should be left for a later time and mostly to the discretion of the patient.

If the patient believes that the reduction of his fracture will enable him to walk immediately, the disappointment he will feel the first days when he finds out how difficult it is for him to move his legs may affect his confidence and interfere with his recovery. Therefore, the surgeon should immediately explain to the patient that his leaving the bed before his fracture is completely healed will not enable him to walk but will make him stronger and will thus help the healing. To be out of bed insures better nutrition, better digestion, a better general condition and, as a consequence, better healing of the fracture.

It is admitted by all surgeons that for old people with fractured limbs, prolonged permanence and immobility in bed is dangerous. But young patients also heal better if their stay in bed is shortened.

Patients should not be urged to walk too soon. Generally, they are too eager to walk. However, once they have acquired confidence, without any instruction, encouragement or assistance, they generally move around and walk within a very short time.

The fractured limb should be so well immobilized that the patient can be taken out of bed without feeling any pain. In the beginning the patient should be satisfied merely to be able to get out of bed for a

while, to sit in a chair and move the limbs that are not affected.

Morgagni said that it is not the number of cases that count, but what you can deduce from them. So I think that a report of a limited number of patients I had under my care at the Columbus Hospital from 1933 to 1943 may serve to show that a great number of fractures of the lower limbs can be treated ambulatorily.

Sometimes on account of the general condition of the patient, or for reasons dependent upon the fracture itself, this treatment was not possible. It was seldom possible to be applied when the fracture was treated with open reduction, but it was very successful when fractures were treated manually and required only a light plaster of Paris bandage to keep the fragments in place.

From January 1, 1933, to December 31, 1942, of a total of 232 cases of fractures of the lower limbs referred to my care, 148 patients have been treated ambulatorily as follows: ten fractures of the neck of femur, five fractures of patella, twenty-three fractures of tibia and fibula, twenty fractures of tibia, sixteen fractures of fibula, forty-nine fractures of malleoli, and twenty-five fractures of bones of the foot.

All these patients were treated as emergency cases, and the fracture reduced immediately or as soon as possible after their admission to the hospital. A plaster of Paris bandage and a metal stirrup were applied at the same time. Patients with fracture of the leg were generally out of bed the next day after admission, some of them a few days later and, on the average, were discharged from the hospital in one month. One patient with intertrochanteric fracture of the hip joint was

out of bed the next day, and able to walk a few days later but generally patients with fractures of the hip joint were out of bed

In the ambulatory treatment of these fractures it is very important to use the right type of splint that will permit the

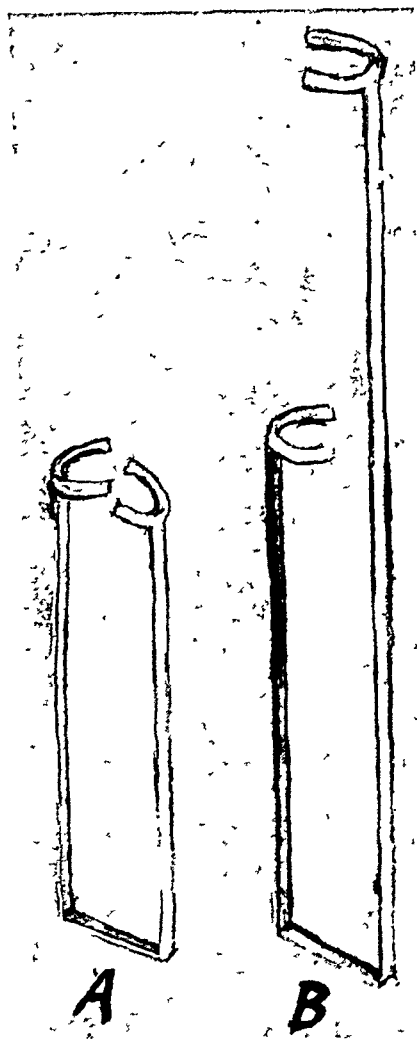


FIG. 1. Models of stirrups: A, for fracture of leg, B, for fracture of hip joint. Each stirrup is made with duralluminum  $\frac{1}{2}$  inch wide and  $\frac{1}{8}$  inch thick. Two plates of pliable metal are attached to the top branches of the stirrup serving to hold the stirrup on the ring of the bandage covering the leg. The bases of the stirrups touching the ground are covered with rubber.

in two weeks and were discharged in ten weeks. No patient was urged to walk until he was ready and anxious to do so. A very few were tardy or reluctant to move, but these patients were also taken out of bed and used the wheel chair.



FIG. 2. Plaster of Paris applied to the leg to show the ring.

patient to walk. The ideal splint should be light of weight, resistant, of simple application and inexpensive. Most of the splints found in the trade are either too heavy or too complicated and all are expensive.

As far back as 1915<sup>1</sup> I suggested the use of a simple metal stirrup as a splint for the treatment of fracture of the leg. Later on I used the same stirrup, but a longer one, in the treatment of fractures of the head of femur. (Fig. 1.)

In the treatment of fractures of the leg and foot, after reduction, the fractured leg is immobilized from above the knee to the foot in a light plaster of Paris bandage with very little padding. At the level of the tuberosity of the tibia, a length of plaster of Paris bandage is applied sideways and rolled around the leg to form a one inch wide and one inch thick ring as a part of the plaster of Paris covering the leg, to serve as a good support to the metal stirrup. (Fig. 2.) This splint is similar to



the stirrup suggested by Reclus for the treatment of fractures of the leg but it is more simple. While Reclus applied his

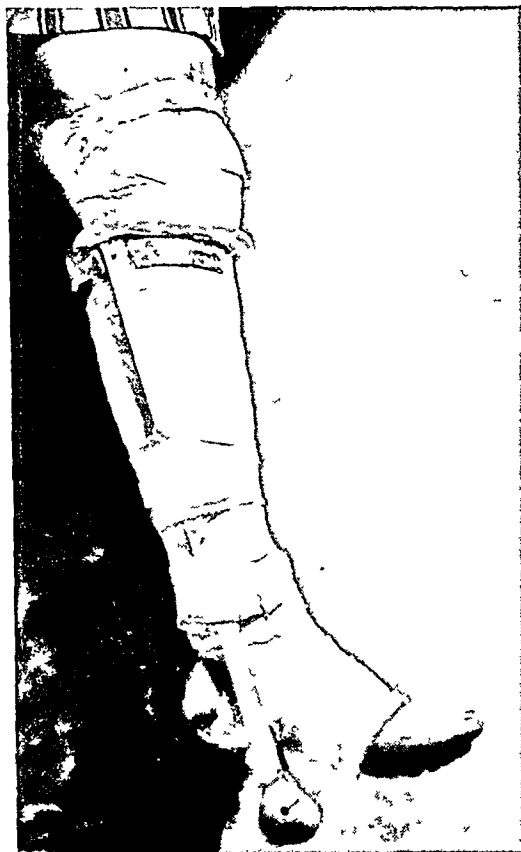


FIG. 3. Apparatus for fractured leg complete, weight three pounds. Some of the bandage was removed to show how the ring supports the stirrup.

stirrup directly to the tuberosity of the tibia, in my cases the splint is supported by the ring built as a part of the plaster of Paris cast covering the leg. The stirrup is longer than the leg so that when the patient is standing, it rests on the floor, the foot remaining suspended and not touching the floor. Thus walking is made easy and there is no danger of traumatic flat foot.<sup>2</sup>

For fractures of the hip joint, the treatment is as follows: After reduction and after having applied a light bandage of plaster of Paris on the whole limb, another stirrup is used, the external branch of which is made long enough to measure the distance from a little below the crest of the iliac bone to the floor, and its internal

branch to reach the middle part of the thigh of the patient. To support the stirrup, the plaster of Paris bandage covering the entire limb is reinforced with two rings, one just below the crest of the iliac bone, circling the lower part of the abdomen, and the other at the middle part of the thigh. When the stirrup is applied its base rests on the floor and the foot remains suspended.

After a while when the patient has learned to walk, it may be well to excise the plaster of Paris bandage covering the leg to permit massage of the muscles of the calf (Figs. 4 and 5), the immobilization of the limb being insured by the bandage on the ankle, the knee and at the thigh.

Years ago when the stirrups were made with iron or steel and were therefore heavy, they were applied to the leg with linen bandages only during the day, and at night were removed to make the patient more comfortable. Some patients had a shoe built around the stirrup which was so laced around the leg that it could be used for walking. At night the shoe was removed with the stirrup. (Fig. 6.)

Now that the stirrups can be made with duralluminum, they are smaller, lighter in weight and are kept fixed, day and night permanently, to the limb with plaster of Paris bandages.

One important thing in this treatment is that in bandaging the limb, only a few plaster of Paris bandages should be used in order that the resulting cast be very light and thin. To insure immobilization, we must trust more to the stirrup than to the thickness of the bandage.

A complete apparatus with stirrup should not weigh more than five pounds for immobilizing a fracture of the femur, and not more than three pounds for a fracture of the leg.

The question of the weight of the apparatus is of primary importance. There is an unfortunate tendency to use too many plaster of Paris bandages and make the cast too thick with the result that walking is very difficult because of weight.



FIG. 4.

FIG. 5.

FIG. 4. Apparatus for fracture of hip complete; weight five pounds. Plaster of Paris bandage was removed from the leg to permit massage.

FIG. 5. Same patient as in Figure 4 seen in profile.

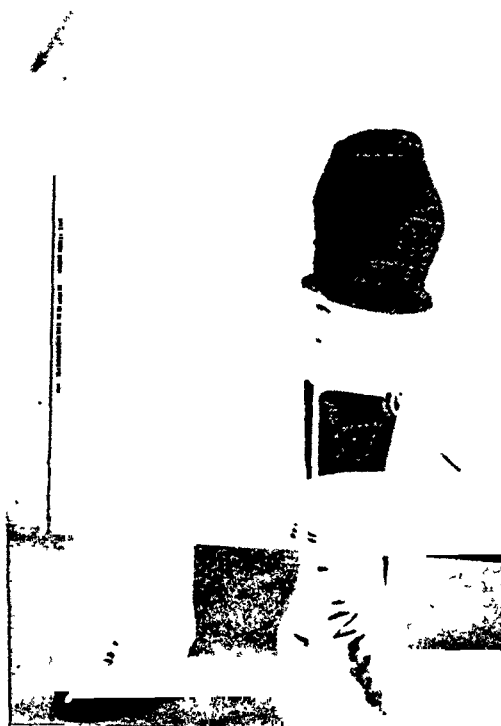


FIG. 6. A shoe was built around stirrup for patient of Figure 2. Stirrup could be removed with the shoe when patient was resting.

In conclusion, I would say that from my experience, about two-thirds of the fractures of the bones of the lower limbs should be treated out of bed by means of the ambulatory treatment. When these patients are discharged after a short stay in the hospital, not only is their general physical condition improved, but their mental tone and their self confidence are at a much higher level than if they had been confined to bed for a long period.

#### SUMMARY

In this article we have discussed (1) the importance of keeping the patient out of bed in the treatment of fractures, (2) statistics of patients with fractures of the lower limbs treated ambulatorily, and (3) the technic of treating such fractures.

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IN a bomb explosion the pressure wave of the blast may produce pulmonary lesions without resultant evidence of injury to the thoracic cage. The lesions are principally due to the impact on the body wall of the pressure component of the blast wave. That this form of trauma produces lesions predominantly in the lung is now abundantly confirmed.

From "War Medicine—A Symposium" edited by Winfield Scott Pugh (Philosophical Library).

# PILONIDAL SINUS\*

## CLINICAL EXPERIENCES WITH THE ROGERS OPERATION IN THIRTY-FIVE CONSECUTIVE CASES

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IN reviewing the literature, one is impressed by the variety of methods offered for the surgical cure of pilonidal sinus. As is usually the case, such a variety indicates a misunderstanding of the condition itself. In 1933, when Rogers<sup>25</sup> presented his first analysis of 119 cases with pilonidal sinus admitted to the Massachusetts General Hospital in the eight years between 1924 and 1931, he found that of the three most commonly used methods (primary closure, partial closure, and open packing) the best results were obtained with open packing. This led Rogers to adopt this method in a large series (140 cases with two failures) as reported in 1938. Rogers' technic is based upon the precept that recurrences are due in most cases to faulty healing rather than incomplete removal. The method consists essentially in three principles: (1) Cautery excision with absolute hemostasis so as to operate at all times in a bloodless field, (2) conservative removal cutting through normal fat as close as possible to the lesion, and (3) open packing allowing the defect to fill in from below.

At the present time interest in the subject of pilonidal sinus has been greatly stimulated by numerous reports from Army and Navy hospitals. The number of operations for pilonidal sinus performed

in the United States during the past year probably exceeds that of the ten previous peacetime years. The present paper reports the results of thirty-five consecutive operations for pilonidal sinus performed on the service done by one of us (H. N. H.) during the years 1940-1942 inclusive.\* This is in the hope that the lessons gained from a study of this series performed in a civilian hospital may be of application, even though indirect, to the management of this condition in military life.

\* As an example of the poor results obtained by a variety of methods used in our own hospital previous to 1938 we append the following statistics concerning seventy-three operations for pilonidal sinus. These cases represent operations performed by various surgeons during the period 1917-1938 and the data concerning them were furnished us through the courtesy of Dr. L. S. Fallis. Seventy-three operations: primary closure, twenty-one; partial closure with drainage, nineteen; closure with flaps, twenty-one; and open packing, twelve; were performed on sixty-six patients. After only fifty-one operations was there an adequate follow-up, and after these there were twelve recurrences (24 per cent). In addition there were thirteen other cases followed for sixty days or less, and nine other cases still unhealed when last seen over sixty days after operation (including one case last seen twenty weeks and another last seen twenty-eight weeks after operation). One of the patients died after a recurrence and in the entire series of seventy-three cases (representing sixty-six patients) there were fourteen who had had a previous operation, seven of these at the Henry Ford Hospital. One of these last seven recurrences resulted in failure at the second operation and a second one of them resulted in drainage being still present when last seen four months after the last operation.

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## HISTORY AND ORIGIN

Kooistra<sup>17</sup> recently reviewed the literature and found that Anderson, in 1847, was the first to report such a lesion in his article, "Hair Extracted from an Ulcer." It was not until late in the nineteenth century that much research was done concerning this condition.

Although considerable work has been done on the origin and etiology of pilonidal cyst and sinus, and many theories have been advanced, there is still a great deal of controversy on the subject. That it is a congenital lesion has been quite conclusively shown, but its true embryological formation seems still to be in question. Two main schools of thought are pre-eminent in the literature of today.

The first school was originated by Hermann and Tourneaux<sup>15</sup> and Mallory,<sup>23</sup> maintaining that pilonidal cysts and sinuses are the result of a failure of obliteration of the lower medullary canal. This view has been worked out in great detail by Gage<sup>11,12,13,14</sup> and Fox,<sup>10</sup> but cases reported by Kooistra<sup>18</sup> and Walker and Bucy,<sup>33</sup> of existence of the lesion in the higher dorsal and even cervical segments throws a new light on the subject. Kooistra states: "Normally, the two medullary folds of the embryo fuse to form a medullary or neural tube, which after four weeks of intra-uterine life has become completely separated from the over-lying cutaneous covering from which it originated. . . . the fact that this case, as well as others reported occurring in the cervical, dorsal, and lumbar regions, showed a communication existing between the skin and the spinal cord or meninges, suggests the probability of an incomplete separation of these structures in early embryonic life as the responsible factor."<sup>18</sup>

The second school originated by Féré,<sup>9</sup> suggests that pilonidal sinuses are due to an infolding of surface epithelium or faulty coalescence of the skin in early embryonic life.

Attempts have been made to ascribe

the pilonidal sinus to an anlage in the early embryo. Stone<sup>31</sup> hypothesized that a downgrowth of skin in the sacrococcygeal region resulted in the formation of cysts and sinuses and compared it to the "preen" gland of fowls. Recently Kallett<sup>16</sup> advanced the theory that these lesions represent growths derived from a vestigial secondary sex gland located in the sacrococcygeal region. These theories have not been widely accepted.

## SIGNS AND SYMPTOMS

The patient usually comes to the clinic complaining of a tender, discharging lesion at the base of the spine. Severe pain on pressure is commonly noted. Low backache with increase in pain on defecation has been described. Quite often the patients have had previous treatment, or have noticed acute exacerbations with periods of remission of symptoms.

The condition usually presented is of one or more sinus openings in the sacrococcygeal area, most commonly located in the midline. In the presence of active infection, a purulent or thin, watery discharge may be expressed, and the surrounding area may be reddened and indurated. In the typical pilonidal sinus, hair may be seen extruding from the sinus tract. Hair was found in nine, or 25.7 per cent of our cases. Secondary sinus openings may appear in various seemingly unrelated positions, often confusing the diagnosis. In one of our cases, no midline sinus was present, while two draining sinuses were noted on either side of the anus. Dissection at the time of operation bore out the diagnosis of pilonidal sinus, located at the usual primary site.

Several writers<sup>6,18,33</sup> have reported structures microscopically resembling pilonidal sinuses occurring in different segments of the vertebral column, from the third cervical vertebra, the upper dorsal vertebrae, and throughout the lumbar and sacral segments. Some of these lesions have been reported as dermoid cysts,

but Kooistra<sup>18</sup> believes that they are definitely pilonidal sinuses.

#### PATHOLOGY

The common structure of a pilonidal sinus is a sinus tract completely lined with stratified squamous epithelium, communicating from the surface of the skin to a deeper cystic dilatation, the whole structure being lined with stratified squamous epithelium. Branching of the sinus may be noted. Hair follicles were noted in nine, or 25.7 per cent of our cases, and occasionally related sebaceous glands may be seen, although their presence is denied by some authors.

Results of infection are present in nearly every case, usually indicated by granulation tissue, neutrophils and lymphocytes. Giant cells, indicating foreign body reaction are quite common. In cases of severe infection the epithelial lining may be partially or entirely destroyed and replaced by scar tissue. Unlike other lesions in which chronic irritation exists, carcinoma arising in a pilonidal sinus is practically unknown.

#### TREATMENT

Many and varied opinions have been advanced in the treatment of pilonidal sinus. To be successful, any form of treatment must completely eradicate the diseased tissue and must control the infection in the process of healing. Thus, excision of the sinus may be considered only the first of two stages, the second being the problem of healing or the attempt to keep the wound healed.

Complete excision of the lesion with primary closure of the wound is, of course, the ideal method of treatment. Many ingenious variations have been employed in the attempt to effect primary closure of these wounds, and such closure may be successful in cases with little or no infection and relatively small lesions. The problem of dead space with ensuing fluid collections has been controlled with various pressure dressings and deep sutures.

The treatment of pilonidal sinus in the present military conditions is a definite problem as is evidenced by the recent literature on the subject coming from our military hospitals.<sup>34,35</sup> De Prizio,<sup>8</sup> in 1942, introduced a new type of operation, employing a partial closure method which seemed well adapted to military conditions, and reported a series of fourteen cases. Scott,<sup>29</sup> in 1943, another military writer, reported good results with the method of primary closure and stated that he believed "primary closure to be the method of choice from a military point of view." This author presented the immediate results in a series of ninety-four cases of excision of pilonidal sinus with primary wound closure. All patients were operated upon by the members of the Surgical Service at the Station Hospital. In no case had a previous operation been performed elsewhere. Twenty-eight of the ninety-four cases received buffered sulfanilamide powder, about 1 Gm. of which was sprinkled into the wound in each case. Primary healing occurred in twenty-seven of these twenty-eight patients (96 per cent). Ordinary sulfathiazole or sulfanilamide powders were used in thirty-seven cases with primary healing in twenty-seven (73 per cent). Because of the military duties of the patients, follow-up studies could not be carried out.

Ambulatory forms of treatment are much in demand today in the armed forces and in war industries, where time lost from work is an essential factor. Attempts to destroy the sinus with various sclerosing solutions such as silver nitrate,<sup>7</sup> chloride of mercury,<sup>2</sup> fuming nitric acid,<sup>3</sup> and a modified Carnoy's solution,<sup>4</sup> have been made, often with gratifying results. Electrocoagulation was first used by Maillard.<sup>22</sup>

All the previously mentioned forms of treatment have been suggested and tried in an attempt to reach some conclusion as to an adequate method of treatment of pilonidal sinus. The greatest problem is that of recurrences, with few series being

reported with a recurrence rates of less than 10 to 15 per cent. Considering all methods of treatment as they might be

In the out-patient department, the operation may easily be carried out with or without assistance, if the patient is

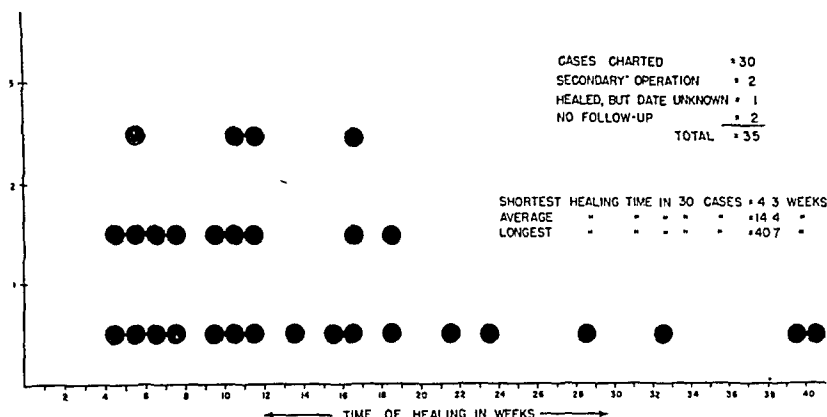


FIG. 1. Healing time in thirty-five patients with pilonidal sinus treated by the Rogers operation.

applied to the general type of case, Rogers' seems to be one of the only methods from which one might expect uniformly gratifying results, meeting all the requirements of sound therapeutic principal, viz: complete extirpation of the diseased tissue; healing in the presence of infection; low recurrence rates; and, little or no loss of time from work. Although Lahey<sup>19,20</sup> devised a method of treatment with a later modification, he was so impressed by the results of Rogers that this method was adopted and almost all recent cases in the Lahey Clinic have been treated by the Rogers method.<sup>21</sup>

#### THE OPERATION

The method of treatment described by Rogers<sup>26</sup> was originally advocated in 1932 by F. D. Stanton of the Dover Street Clinic.<sup>30</sup> Although it was used as an out-patient procedure with local infiltration anesthesia, we have used a small amount of spinocaine for some of the larger lesions on in-patients. Most of the patients not treated by the ambulatory method have been so managed because they had hospitalization privileges and it was cheaper for them to be admitted. Local novocaine anesthesia was used in twenty cases; spinocaine, 1 cc., in fourteen cases, and general anesthesia in one case.

placed on a rectal examination table with the head tilted down. Adhesive straps may be placed on each buttock down over the sides of the table, thus serving as retractors. In-patient operations are done on a regular operating table with the patient in the regular position, again using adhesive straps as retractors.

Although Rogers<sup>26</sup> used the Post cautery, we have used the Bovie on in-patients and a modified radio-cautery on out-patients. Instead of the midline incision, a narrow ellipse of skin is first marked out above the sinus tract or cyst. In our series, those cases which were left without over-hanging edges healed much more rapidly. The cautery knife provides a bloodless field which facilitates the recognition of unstained diseased tissue, not only by its appearance but by the fact that such tissue is less readily divided by the cautery knife than is normal fat. The dissection is carried down to the sacrococcygeal fascia, staying as close as possible and yet not incising the diseased tissue, thus removing the tract *en bloc*. If secondary sinus openings are present away from the midline, the incision is extended to and includes this opening. The resultant narrow cavity is then packed, usually with dry gauze, and a small dressing is applied.

*After-care.* In ambulatory cases, the patient is allowed to return home immediately, and may go to work the same or the next day. After the first dressing on the fifth or sixth day, he is instructed to leave the new pack undisturbed for two days, and then to remove it in a sitz bath on the third day. Following the removal of the pack, the patient takes two sitz baths a day, applying a dry sterile dressing himself, very conveniently consisting of a rather large cotton pad held in place by a T-binder. The patient is then requested to return to the clinic twice a week for the first few weeks, and then comes in for weekly visits. Hospital patients are treated in a similar manner, and continue their treatment at home.

As healing progresses, some wounds are exceptionally moist and the surrounding skin tends to become quite macerated. The patient is instructed to dust the surrounding area with powder, usually zinc stearate, and to change the dressing frequently. At clinic visits, the wounds are usually cleaned with hydrogen peroxide and may be dusted with a small amount of sulfanilamide powder which effectively combats surface contamination and infection. Inadequate and unhealthy granulations are cauterized with silver nitrate applicators and are stimulated with balsam of Peru packs. Balsam of Peru also acts as a partial deodorant in most cases.

In the terminal stages of healing, some wounds have a persistent tendency to form epithelial bridges, leaving small sinus tracts. These bridges must be continuously broken down, thus eliminating the possibility of recurrence of symptoms from residual sinus tracts formed on healing. Frequent clinic visits are almost more important during the last few weeks of healing than during the initial stages of the management as Rogers has so well pointed out; the whole success of this method depends on assiduous care by one man, preferably the original operator, during the entire course of convalescence.

## ANALYSIS OF CASES

*Sex.* In our series of cases, there are 9 females, or 25.7 per cent and twenty-six males, or 74.3 per cent. This is in almost direct accord with the cases reported by Rogers,<sup>26</sup> whose male:female ratio was 3:1. Burgess<sup>5</sup> reports a ratio of 8:1 in forty-five cases, while Kooistra's<sup>17</sup> study of 350 cases showed a ratio of 3:1, with 73.7 per cent males and 26.3 per cent females.

TABLE I  
SEX INCIDENCE OF THIRTY-FIVE PILONIDAL SINUS CASES

	No.	Per Cent
Female.....	9	25.7
Male.....	26	74.3
	35	100.0

*Age.* The average age of our cases was 28.34 years, the male average being 30.8 years, and the female average being 21.2 years. This is slightly higher than those reported by Kooistra,<sup>17</sup> and De Prizio.<sup>8</sup> The period of greatest frequency in our series was the decade between twenty and twenty-nine years as shown in Table II.

TABLE II  
AGE INCIDENCE OF THIRTY-FIVE PILONIDAL SINUS CASES

Age in Years	No. of Cases
15-19	6
20-24	8
25-29	9
30-34	4
35-39	2
40-44	2
45-49	3
50-60	1
Total.....	35

*Duration of Lesion.* Almost one-half of the series (fifteen) had only been conscious of their lesion for one year or less. All cases offered surgical relief accepted the same without hesitation, indicating that while pilonidal sinus is not a serious condition it is aggravating enough to warrant adequate and critical surgical attention.



TABLE III  
DURATION OF SYMPTOMS IN THIRTY-FIVE CASES OF  
PILONIDAL SINUS

Duration	No. of Cases
1 wk. to 1 yr	15
1 yr to 5 yrs	8
5 yrs. to 10 yrs	7
10 yrs. to 15 yrs	1
Not known	4
	35

*Previous Operation.* Although Rogers<sup>38</sup> stated that all pilonidal sinuses may be considered as being infected, it is not necessary that all evidence of acute infection be cleared before cautery excision. Eleven cases of the series were classed as recurrent, having had some form of surgical intervention before being seen in this hospital. Four cases were so severely infected with abscess formation that incision and drainage followed by daily sitz baths for one or two weeks was necessary before total excision of the lesion could be accomplished.

TABLE IV  
PREVIOUS OR PRELIMINARY TREATMENT IN THIRTY-FIVE  
CASES OF PILONIDAL SINUS

Operation	No. of Cases
Incision and drainage	8
Previous operation elsewhere	7
None	20
	35

*Duration of Infection and Drainage.* Again it is interesting to notice that the presence of an actively infected and draining wound prompted the greater percentage of our cases to seek early treatment.

TABLE V  
DURATION OF DRAINING WOUND BEFORE OPERATION IN  
THIRTY-FIVE CASES OF PILONIDAL SINUS

Duration of Drainage	No. of Cases
1 wk. to 2 mos	14
3 mos. to 4 mos	3
4 mos. to 6 mos	2
6 mos. to 1 yr	6
1 yr. to 5 yrs	2
6 yrs. to 10 yrs	1
Not known	7
	35

*Anesthesia.* All out-patient operations were carried out under local infiltration

anesthesia. Novocaine 1 or 2 per cent is used, effectively blocking off the area. Care must be taken not to spread infection into surrounding tissues at the time of injection. A spinal anesthetic of  $\frac{1}{2}$  to 1 cc. of spinocaine acts very effectively, and was used in most of the in-patient cases. One patient was so apprehensive that it was necessary to use a general anesthetic.

TABLE VI  
TYPE OF ANESTHESIA IN THIRTY-FIVE CASES OF PILONIDAL  
SINUS

Anesthesia	No. of Cases
Local-novocaine	20
Spinal-spinocaine	14
General	1
	35

*Sinuses.* The majority of our cases presented only one sinus tract at the time of operation. Primary sinus tract openings are usually in the midline, but infection and abscess formation may produce secondary openings quite distant from the midline, and may occasionally be mistaken for the openings of fistulae-in-ano.

TABLE VII  
NUMBER OF PRESENTING SINUSES IN THIRTY-FIVE CASES  
OF PILONIDAL SINUS

No. of Sinuses	No. of Cases
One	24
Two	7
Three	3
Four	1
	35

*Operation.* Twenty-three of our cases were done as in-patient procedures and twelve were done in the out-patient Department. The greater number of hospital patients may be directly attributed to the fact that most of the patients in this territory are employed in large industrial firms, thus carrying hospital insurance.

TABLE VIII  
PLACE OF OPERATIONS IN THIRTY-FIVE CASES OF  
PILONIDAL SINUS

Operation	No. of Cases
In-patient	23
Out-patient	12
	35

*Hospital Stay.* As was stated above, most of our patients who stayed in the hospital carried hospital insurance. Therefore, the hospital stay is somewhat longer than was usually absolutely necessary in most of the cases. For the twenty-three hospital cases, the average stay was 6.5 days.

TABLE IX  
LENGTH OF HOSPITAL STAY IN HOSPITALIZED PATIENTS  
WITH PILONIDAL SINUS

Hospital Stay	No. of Cases
1-3 days	4
4-6 days	10
7-10 days	7
11-17 days	2
	—
	23

*Postoperative Visits.* After the first one or two postoperative weeks, the patients usually made weekly visits until the terminal stages of healing when they would return every two weeks. The patients were instructed as to interval treatment and usually became quite adept at caring for their own wounds. The average number of postoperative visits made in this series was 10.3, the highest number, twenty-seven visits, and the lowest number, three visits.

*Healing Time.* Although the healing time presented in this series may seem quite long, it closely agrees with that reported by Rogers.<sup>27</sup> Operations employing complete or partial closure may result in a much shorter healing time but the percentage of recurrence from these procedures entirely vindicates the Rogers technic. As seen in Figure 1, the average healing time in thirty cases was 14.4 weeks, the longest was 40.7 weeks, and the shortest was 4.3 weeks. If the six cases healing the slowest are excluded, the average in the remaining twenty-four cases was 10.3 weeks. In two cases we were unable to determine the time of healing, in one case the wound healed but the date is not known, and in two cases a secondary operation was later required as discussed below. In these last two cases which are not included in the averages, the primary healing occurred

in 11.1 and 12.3 weeks, respectively. The two other cases healing the slowest represent an interesting contrast. One, L. R., a male, aged eighteen years, was in perfect health, was not obese and was very actively employed as a gardener all during the healing period. The other, D. B., a female, aged sixteen years, was extremely obese, hypothyroid, required three or more grains of thyroid a day, and led an extremely inactive life.

*Follow-up.* We have been able to follow closely the results on thirty-two of our thirty-five cases. Thirty of these thirty-two cases have been healed for varying intervals of from at least six months to slightly over three years as shown in Table x. This represents a primary healing of 94.6 per cent of the cases.

The other two cases, representing 5.6 per cent of the material, do not represent true recurrences but possibly incomplete excisions of accessory openings or faulty healing. Summaries of these two cases are appended for completeness:

CASE I. E. B., male, aged twenty-one years, was operated upon for pilonidal sinus by the Rogers method on June 23, 1942, but for some undetermined reason returned to another staff member for postoperative care. The original wound was pronounced healed on September 10, 1942 (eleven weeks, one day). On January 3, 1943, the patient returned to the authors for a check-up and a small sinus was found 15 mm. deep, in the midline, about 1 cm. below the lower end of the previous excision, and from which a single hair was protruding. Under local anesthesia, this lesion was excised with the cautery and the secondary wound was healed two weeks later.

CASE II. F. P., female, aged nineteen years, was operated upon for pilonidal sinus by the Rogers method on February 17, 1941. Healing was accomplished by May 14, 1941 (twelve weeks, two days). Repeated visits indicated continued healing of the wound, but on March 4, 1942, practically ten months after the healing date, she came in to the clinic complaining of a small lump with no discharge of two weeks' duration. Examination revealed a lump about 4 mm. in diameter in the midline about 1.0 cm.

above the upper end of the scar of the previous excision one year before. This lump was excised under local anesthesia. The resultant secondary wound healed by March 21, 1942 (seventeen days). Pathologic examination indicated an infected sebaceous cyst. On January 13, 1943, both wounds were still healed.

As to whether or not these cases represent true recurrences, we will allow the facts to speak for themselves. In neither instance did the secondary condition or recurrence occur in the line of the previous scar as is the usual case with typical recurrence of pilonidal sinus after operation. Rogers (1938) had two similar cases and his comment on them is as follows: "These small openings were missed, presumably because at the time of operation they contained no hair. Even had they been seen, as with more care they would have been, it is probable that the same operative procedure would still have been carried out, but with the expectation of a second stage if developments should still prove it to be necessary." A longer excision could also be done in such cases and still the resulting wound be smaller than with the conventional "wide" excision.

TABLE X  
LENGTH OF FOLLOW-UP IN THIRTY-FIVE CASES OF  
PILONIDAL SINUS

Years Healed	No. of Cases	Per Cent
3½ yrs	1	2 8
3 yrs	2	5 7
2½ yrs	1	2 8
2 yrs	4	11 4
1½ yrs	8	22 9
1 yr	3	8 6
½ yr. or less	14	40 1
Unable to follow	2	5 7
Total	35	100 0

These cases also clearly illustrate the importance of postoperative care of these lesions. We believe as Rogers<sup>28</sup> first stated, that each case should be under the care of the same surgeon, from first to last. Most recurrences are not due to the fact that some diseased tissue was left at the

time of the original operation, but to neglect or misunderstanding of the post-operative care of the wound.

#### COMMENT

The most obvious disadvantage of this method of treatment of pilonidal sinuses is the long healing time which averaged 14.4 weeks in thirty of our cases. Factors increasing this time seemed to be especially obesity and overactivity or prolonged sitting while at work. In one case with delay, marked hypothyroid function may have been a factor. Careful postoperative care is very essential especially during the last few crucial weeks when epithelium may grow down into clefts between granulations or under overhanging skin edges.

The small amount of tissue removed allows the operation to be performed under local anesthesia on ambulatory patients with minimum cost and shock to the patient. The rationale of this procedure is that recurrences are not so much a result of incomplete removal as of faulty healing. It is usually not the sinus epithelium left behind but the newly formed scar epithelium that causes trouble. This does not mean at all that the operation should be incomplete. However, the use of the cautery and operating in a field that is kept bloodless at all times, allows one to shave off the normal fat quite close to the lesion. Good visibility and keeping in normal fat at all times are essentials. There is no need of sacrificing a pound of flesh just to be sure of removing all the lesion.

When in rare instances recurrence does occur in cases operated upon by this method, the lesion is not large, and little larger if any than the original lesion. Usually when the conventional radical or flap procedures are done and failure results, the secondary lesion is far bigger and more painful than the original pilonidal sinus. Furthermore, when done by the Rogers method, recurrence is rare, and the resulting scar is small and almost invisible.

## SUMMARY AND CONCLUSIONS

1. The use of the Rogers operation in thirty-five consecutive cases of pilonidal sinus treated on one surgical service between March 7, 1940, and September 15, 1942, is discussed.

2. This method involves the application of a conservative cautery removal of the sinus, preferably as an ambulatory procedure.

3. Disadvantages of the procedure are the long healing time, averaging 14.4 weeks in our series, coupled with the necessity for careful postoperative care, preferably by the original surgeon.

4. Advantages of the procedure are: (1) Low cost of ambulatory care; (2) small amount of tissue removed obviating general anesthesia and producing a small wound and small subsequent scar, and (3) high percentage of primary cures with low recurrence rate.

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# BREAST TISSUE AS A NEW SOURCE FOR HETEROGENOUS IMPLANTS

## PRELIMINARY REPORT

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THE urgent need for suitable tissues as grafts or implants has spurred surgeons, especially those engaged in the reparative field, to seek new sources of supply.

tempted by Russian surgeons and then by American colleagues. The tissue is hardened in 10 per cent formaldehyde for two weeks and is then washed in alcohol, sterile water and saline solution.

The transplantation of cornea and the establishment of a "bank" for its preservation are of absorbing interest. There is still, however, a great need for adequate quantities of normal tissue to be utilized, either fresh or preserved, in one manner or another.

Heterogenous grafting of fatty, subcutaneous tissue, procured from hips, buttocks or abdominal wall, was widely carried out during World War I and reintroduced in the present conflict. These grafts are commonly used for filling depressions and extensive, deep wounds.

Adipose tissue obtained even under the best conditions admittedly tends to liquefy in about seven to thirty days. It contains little fibrous stroma which, however, when transplanted under the most favorable conditions, tends to grow. This tendency is often negated in war wounds and deeply depressed scars.

The need for tissue preservation (uncontaminated and as far as possible free of bacteria) in reparative surgery has led me to experiment with certain varieties obtainable in large amounts.

I have in some cases successfully used fresh, and in others, preserved breast tissue obtained from pendulous and hypertrophic mammae. No valid conclusions can, of course, be based on the few cases cited herein but the preliminary data may stimulate workers in the field of reparative surgery to salvage for subsequent use the



FIG. 1. Mastectomy scar (scirrhus cancer).

In various medical articles recently published the authors maintained that only embryonic tissues can be successfully utilized as heterogenous grafts. This view is perhaps based on the theory that this tissue possesses, so to say, the primary impulse of cell division which can withstand possible catabolic processes. Then, again, other theorists have recently experimented with placental epithelium used within twenty-four hours of childbirth. Of transcendent interest is the transplantation of cadaver nerve grafts first at-

only healthy, human tissue available in large quantities.

#### CASE REPORTS

In my first attempt along this line I obtained the graft in carrying out a cos-

dyspneic attacks. The surgical indications here were ameliorative rather than cosmetic.

The patient was admitted to the hospital on March 13, 1944. On physical examination her breasts appeared normal and the subsequent microscopic examination revealed no

FIG. 2.

FIG. 3.



FIG. 4.

FIG. 5.

FIG. 2. Scar removed; recipient area prepared for implant.

FIG. 3. Heterogenous implant, breast tissue.

FIG. 4. Implant sutured into position.

FIG. 5. Skin closed after placement of implant.

metic operation on pendulous and hypertrophic breasts:

The patient, thirty-three years of age, was painfully inconvenienced and, at times, disabled by the great weight of her breasts which reached the umbilicus and during the summer by continuous outbreaks of eczema and

evidence of cystic degeneration or malignancy. A strong fibrous network was present.

The presurgical tests disclosed that the patient's blood grouping was of Type O; sedimentation rate, two hours; coagulation time, three minutes and hemoglobin 80 per cent. The blood count was as follows: red

blood cells 4,180,000; white blood cells 6,000; polymorphonuclears 63; small monocytes 34.

More than one-half of the breast tissue in its

(right) amputation for scirrhus cancer. No glandular involvement was discoverable at the time of the first operation. In due time the



FIG 6 A, preserved breast tissue (eight weeks), B, preserved breast tissue (ten weeks)

entirety, comprising the upper segment, was resected during the course of the reconstructive operation. This tissue was washed immediately, thoroughly freed of blood in sterile, body temperature, normal saline solution. It was then placed in a similar solution over hot water. The operation was continued and an analogous resection was carried out on the other breast. This segment was treated in the aforesaid manner.

In the interim a second patient was prepared for operation. She had suffered a breast

surgeon sanctioned an attempt at surgical replacement of the gland.

The clinical examination of this patient showed an o blood type; sedimentation rate, over two hours; coagulation time three and one-half minutes; hemoglobin 90 per cent; red blood cells 4,350,000; white blood cells 5,800; polymorphonuclears 59; small monocytes 37.

During the surgical procedure on this patient the entire scar (which passed two and one-half inches from the mid-axillary line to the ninth sternal cartilage) was opened and the

skin covering the area of the previous operation was widely undermined laterally and above the serratus anterior and toward the sternum,

eighth day her menstrual period began and at a change of breast dressings a bloody discharge mixed with fine, fatty cells, was noted from

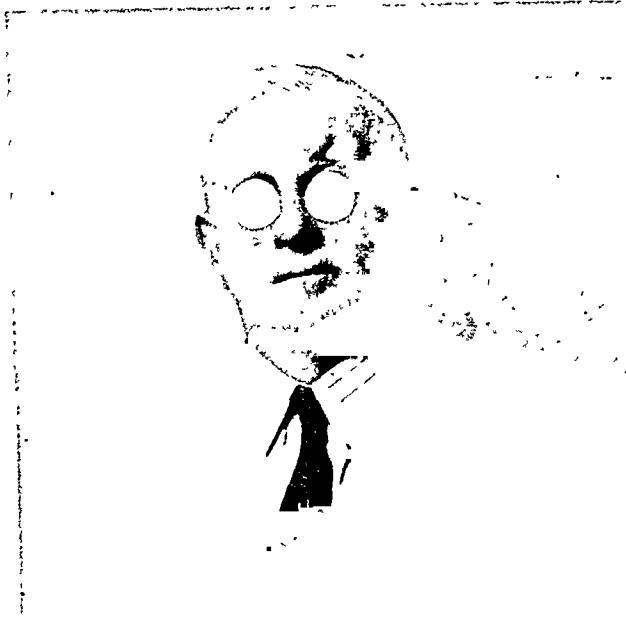


FIG. 7. Depressed scar of frontal bone.

up to the margin of the left normal breast. Under the most aseptic precautions the heterogenous graft, obtained in the previous operation, was removed from the normal saline solution, patterned to approximate an oversized, normal breast, and implanted in the area of the missing right breast of the other patient. The implant was sutured in position with No. 1 plain catgut. Interrupted intracutaneous catgut sutures approximated the subcutaneous tissue of the recipient area and over these a layer of interrupted silk sutures closed the skin.

This patient was admitted to the hospital on March 13, 1944. For the first seven postoperative days there were no incidents of moment. The temperature, immediately following the operation, was 100.8°F. and remained normal thereafter until the patient was discharged from the hospital on March 29, 1944. On the

the graft. It continued for five days and had ceased when she was discharged from the hospital on the twenty-sixth day. Three days later she returned for a change of dressing and recurrence of the sanguineous and fatty discharge was evident from the upper part of the implant. The flow continued for ten days when the slough was found to be aseptic, containing only leucocytes and fatty detritus.

The patient was treated with infra-red rays. On the twelfth day a demarcation line was manifest and the resultant cavity in the aforementioned area was strapped with sterile adhesive tape. The dressings were changed for the next three weeks and the infra-red ray treatments continued. A thick stratum of subcutaneous tissue formed and lined the cavity symmetrically. The residual implant—four-fifths of the total dimensions—remained unaffected. During all the dressings it was evident



that the graft had become firmly adherent to the subcutaneous epidermal layer but the base of the recipient area was loosely affixed.

Eight weeks after the operation an additional

temperature of 45°F. Three days later a bacteriologic test showed no bacterial growth. The same was true after a lapse of six days following a seventy-two-hour incubation test.

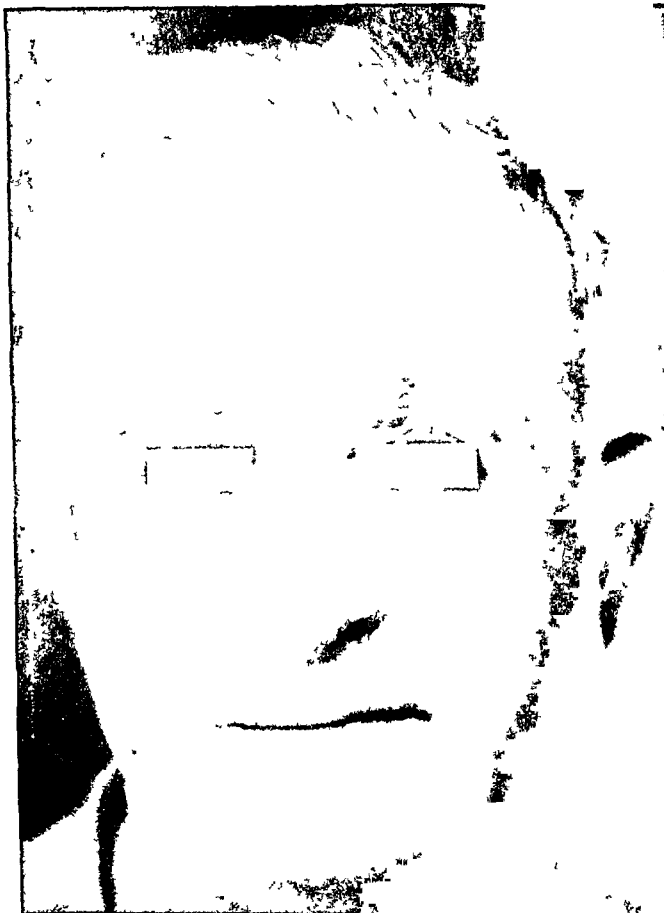


FIG 8 Implant of preserved breast tissue in frontal bone

row of catgut sutures (No. 2, plain) was inserted, uniting the hiatal margins of breast tissue. Within three days additional sloughing occurred from the center of the small, upper graft segment. This lasted ten days. During this time packs with tyrode solution were applied. In forty-eight hours complete demarcation occurred and the hiatus was abridged with sterile adhesive strapping.

During the last four weeks the entire process has remained stationary. A final report will be published after a complete secondary reparative operation within a few months.

The surplus of breast tissue from the first cosmetic operation was transferred, under absolutely aseptic conditions, from the body temperature, saline solution to sterile tyrode solution. The immersed tissue was kept at a

On the seventh day part of this preserved tissue was utilized in two operations. In the first, a portion was implanted in the forehead of a seaman, forty-eight years of age, who had suffered an injury when a cylinder blew up and fragments thereof crushed his frontal bone. The roentgenographic examination disclosed two defects, each about the size of a quarter of a dollar, one above the left superciliary ridge and the second about one-quarter of an inch higher and lateral. The depressed scar passed from the upper and inner canthus of the left eye at an angle of 30 degrees into the hairline.

When the scar was excised and the circumjacent margins undermined, the dura mater was exposed. The recipient area here was circumspectly cleansed and hemostasis carried out.

A piece of preserved breast tissue was immersed in normal saline solution, washed thoroughly and cut to correspond to the dimensions of the defect to be obliterated. The

and discoloration had subsided. There was primary healing on the seventh day.

The permanence of the inlay appears to be certain after an interval of three months.



FIG. 9 Saddle nose.

tissue, on removal from the tyrode solution, showed no signs of decomposition as previously tested by the universal indicator. It had remained firm and the fibrous structure was clearly visible.

The graft was sutured to the margins of the defect with fine, plain catgut strands and the skin with fine silk. A solution containing 20 gr. of sulfathiazole, 20 cc. peroxide of hydrogen and 70 cc. of normal saline, was used for irrigation. The paste-residue of this solution was placed on the sterile dressings. Ice compresses were applied for the first twenty-four hours.

There were no local changes during the first surgical day, except collateral edema and discoloration of the left upper and lower eyelid. The temperature remained normal. A supplemental application of sulfathiazole powder was made at the re-dressing. On the third day the patient was discharged from the hospital.

On the fifth post-surgical day the swelling

Breast tissue implant was next utilized in the correction of a saddle-nose. The patient, seventeen years of age, also showed a complete destruction of the nasal septum. (A Wassermann test was reported negative.)

The implant was sutured into position in the customary manner and at the present writing the result appears to be highly gratifying to the patient and surgeon.

#### LABORATORY REPORT (TOBACH)

*Steps in the Preservation of the Tissue in Vitro.* The steps are as follows:

1. March 14, 1944—Two jars containing Tyrode solution were in autoclave for one-half hour.

2. While the Tyrode solution was still warm, the washed tissue was placed in both jars employing aseptic technic and sealing the jars tightly.

3. The jars were kept in the refrigerator at all times at 50°F.

4. March 19, 1944—Three tubes were

9. April 11, 1944—Solution in the jars appeared very turbid. Many pieces of tissue were suspended in the solutions,



FIG. 10. Correction of contour with preserved breast tissue.

inoculated containing dextrose broth with the solution contained in the jars using the fourth tube as a control.

5. The tubes were incubated for seventy-two hours. The bacterial report was negative.

6. March 21, 1944—Tissue was taken from the jars and used for heterograft implantation—two cases.

7. March 22, 1944—Three tubes containing dextrose broth were inoculated with the solution contained in the jars which now appear turbid. Contamination was suspected.

8. March 23, 1944—Bacterial culture was positive after twenty-four hours incubation: Hay bacillus, *Bacillus coli*, staphylococcus, and diphtheroids.

probably due to bacterial contamination. The surface of the mass tissue appeared discolored and disorganized as compared to its original macroscopic appearance. Two large pieces of tissue were removed cutting them down to 1" by 1 by ½" in size (9 pieces.)

#### DISREGARDED ASEPTIC TECHNIC

The cut tissue was washed successively in saline, Tyrode solution and distilled water for several minutes and each piece embedded individually in separate jars containing Tyrode modification. The jars were sealed with paraffin.

3 Jars Tyrode Modification "Plain"

3 Jars Tyrode Modification with "Sulfathiazole 5%"

3 Jars Tyrode Modification with "Phenol ½%"

10. April 26, 1944—The tissue was taken from Tyrode modification "Plain" and sectioned by Dr. Rhodenburg.

tion of distilled water the pH rises to 8.0. Upon the addition of phenolphthalein indicator to a water solution containing

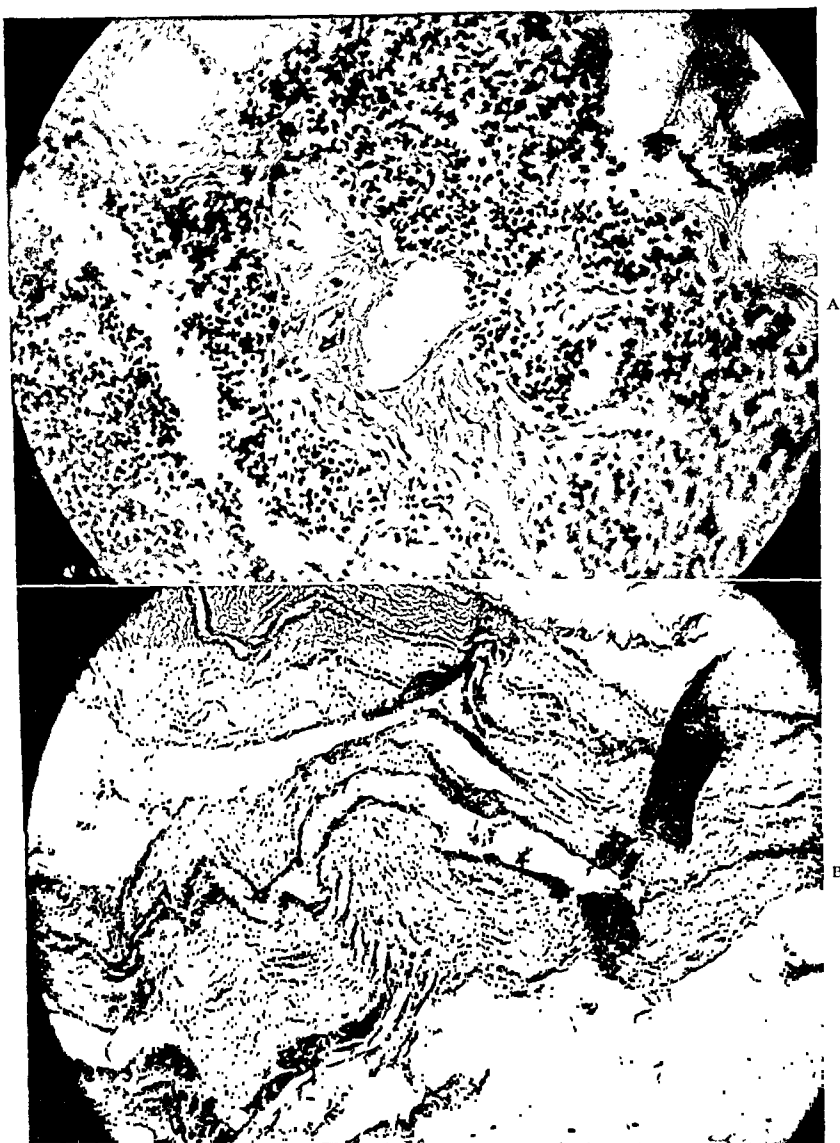


FIG. 11. A and B, breast tissue after five months of preservation.

11. May 8, 1944—The tissue was taken from Tyrode modification with "Phenol" and Tyrode modification with "Sulfathiazole" and sectioned by Dr. Naumann. They were examined also for sterility after ninety-six hours of incubation.

#### TYRODE MODIFICATION (TOBACH)

Tyrode modification is a semi-solid amphorteic material exhibiting a pH of 5.5 in the original state and upon the addi-

Tyrode Modification no color change is evident. Upon heating, transition to the alkaline side takes place pH 8.00, and upon cooling solution becomes colorless. Tyrode modification possesses the property of being both a conductor and condenser of electrical activity. It is composed of two phases, the aqueous represented as Tyrode solution and the oleoagenous phase as glyceryl and cholesterol esters, organic acids and higher alcohols. Tyrode modi-

fication possesses a very high penetration index and with the aid of gentle friction will pass through the intact skin within seconds. Applied as a thin coating to the skin, absorption will take place within twenty-four hours. It will not macerate the skin or cause any destruction to any of the glandular structures and surrounding tissue.

#### EXAMINATION OF TISSUE (DR. NAUMANN)

*Macroscopic Description.* Specimens consisted of two irregular fragments of yellowish tissue embedded in a white semi-solid material and each was submitted in a separate jar marked No. 3 and No. 7.

*Microscopic Examination.* Sections of both specimens showed fat tissue with islands of connective tissue and tubo-alveolar glands and ducts characteristic of mammary gland. The cell structures were well defined without any evidence of autolytic changes. The preservation of the tissue appeared such as obtained by the routine procedure of immersing specimens into formalin solution immediately following operation.

#### BACTERIOLOGIC EXAMINATION OF TISSUE

Two specimens of mammary fat tissue as described above were examined for sterility by transferring fragments of each measuring about 5 mm. in diameter under sterile precautions into brain-heart infusion broth. Some of the white preservative adhering to the tissue fragments was partly dissolved in the broth. After an incubation period of four days no bacterial growth was obtained.

#### LENOX HILL HOSPITAL

*Pathologic Examination* (May 29, 1944). Microscopical examination of prepared slides reveals breast tissue. This tissue is well preserved, and its abundant stroma is partly sclerosed. Embedded in it are groups of acini, most of which are small and lined with single or double rows of cuboidal epithelial cells having a scanty cytoplasm, and deeply staining, hyperchromatic nuclei. The small lumina are either empty or contain some eosinophilic

staining material. A few of the acini are enlarged and elongated, and here the lining epithelium is partly desquamated. Diagnosis: Well preserved, atrophic breast tissue. (R. M. Paltauf, Pathologist.)

#### PARK EAST HOSPITAL, NEW YORK LABORATORY DIVISION

*Examination* (May 30, 1944). Nature of specimen: Breast tissue. Macroscopic: Breast tissue received fixed in oily fixative. Microscopic: The tissue consists of very fatty breast tissue with well stained nuclei. The nuclei take the stain with no definite evidence of degeneration. Diagnosis: Fatty breast tissue—no evidence of degeneration. (Arthur Schiffrin, M.D.)

#### DR. NAUMANN CLINICAL LABORATORY

*Bacteriologic Examination of Preserved Tissue* (August 8, 1944). The tissues supplied in two jars, marked "8" and "4," embedded in a white semi-solid mass were cut under sterile conditions. Two pieces from each were transferred directly into brain-heart infusion broth and two pieces from each were first washed in sterile saline (in order to remove the adherent white preservative) before transferring them into the broth.

After three days' incubation there is little change in the macroscopic appearance of the broth which was turbid from the start, especially in the two tubes containing the unwashed tissue pieces due to admixture of the preservative. Smears are difficult to interpret due to the fact that the admixed fatty preservative prevents proper staining even after ether extraction and by use of alcoholic stains.

One of the broth cultures containing an unwashed piece of tissue was used to pour on an agar plate. After three days' incubation five small white colonies, consisting of staphylococci grew, inside the agar. Agar plates inoculated from the rest of the broth cultures did not show any growth after five days' incubation.

*Histological Examination* (August 8, 1944). The tissues are supplied in two jars marked "8" and "4" embedded in a white semi-solid mass. Both specimens are irregular pieces of fatty tissue measuring about 3 cm. in their greatest dimension.

Microscopic examination reveals breast tissue, the fat cells and connective stroma of which are normal and well preserved. The

epithelial elements of the glands and ducts are also essentially normal and well preserved except for occasional shrinking of the nuclei. The latter, however, stain well and show no evidence of degenerative changes. Diagnosis: Normal breast.

#### CONCLUSIONS

1. Tyrode modification has beyond any doubt proved to be the ideal preservative

for human tissue. Its action is, in all likelihood, due to its electrolytic power, substituting local blood circulation.

2. Tyrode modification is recommended in cases of inflammatory reaction and of disturbed post-surgical blood circulation as a therapeutic means. Its therapeutic value is perhaps due, as aforesaid, to the electrolytic properties of the preparation.



CYSTS of the breast are usually due to blockage of the secreting mechanism, either by fibrosis from without or obstruction from within the lumen.

From "A Short Practice of Surgery" by Hamilton Bailey and R. J. McNeill Love (H. K. Lewis & Co. Ltd.).

# CONTINUOUS CAUDAL ANALGESIA IN OBSTETRICS\*

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IN a preliminary report<sup>1</sup> we described our modification of the original technic of fractionally continuous caudal block analgesia in obstetrics, as advocated by Hingson and Edwards.<sup>2</sup> Instead of administering repeated injections, we set up a continuous infusion drip after the effect of the initial dose has been established.

We believe that this latter method is more practical, as it eliminates three disadvantages of the original method, namely, (1) The obstetrician need not return to his patient at specific intervals of thirty to forty minutes, but at convenient times. The patient can be watched by any attendant and seen at will; more than one patient may be cared for by a single attendant. (2) The advantages of continuous caudal block can be rendered to a large proportion of the parturient population without the need of the specially manufactured apparatus described by Hingson and Edwards.<sup>2</sup> The implements for continuous drip, which are readily improvised, consist of any container, preferably graduated, and an ordinary Murphy drip infusion tubing of the type generally used for venoclysis. (3) Once set up, the infusion drip is automatic and does not require the frequent handling necessary in the fractional technic; less handling means less chance of contamination and infection.

Since our preliminary report<sup>1</sup> we have analyzed 130 cases of caudal block performed between November, 1942, and May, 1943; of these, fifty were single injections, twelve were of the fractional type and sixty-eight were continuous drip infusions. In the first 115 cases 2 per cent

procaine was used, and in the last fifteen cases 1½ per cent metycaine. We used the special malleable needle, an ordinary 19G spinal needle, at first one 3½ inches long, then one cut down to 2½ inches. In the last cases we employed the catheter method described independently by Manalan<sup>3</sup> and Adams, Lundy and Seldon;<sup>4</sup> this is discussed below under *Technic*. The caudal blocks were all administered by obstetricians.

In these 130 cases we studied: (1) dosage required for the full initial effect and for subsequent maintenance, (2) latent period between time of injection and full initial effect, (3) required duration of continuous drip, (4) subsequent length of first and second stages of labor, (5) variation in blood pressure and pulse, (6) duration of caudal block after discontinuation of the drip infusion, (7) effect on the cervix and on uterine contractions, and (8) complications.

## TECHNIC

We follow the technic described in our preliminary report,<sup>1</sup> except that, as stated above, we have cut the 19G needle to a length of 2½ inches, which insures its being buried up to the hillock. If a portion of the needle is left outside the skin, the possibility exists that the needle may be accidentally and unknowingly pushed further into the caudal canal during the drip infusion, and that it may then insidiously pierce the dura mater. This contingency is eliminated by our revised technic.

A safer method is the catheter technic independently described by Manalan,<sup>3</sup> and

\* From the Obstetric Service of Dr. Frederick A. Kassebohm at Harlem Hospital, New York City.

Adams, Lundy and Seldon.<sup>4</sup> We prefer to use the 19G needle for the initial dose. The usual precaution of waiting ten minutes after the test dose of 6 cc. of 2 per cent procaine or 8 cc. of 1½ per cent metycaine is observed. After the full effect has been achieved, the 19G needle is replaced by a 13G needle. A No. 5 ureteral catheter is threaded through the latter into the caudal space, after which the needle is removed. A 21G needle ½ inch in length is used as an adaptor between the distal end of the catheter and the infusion tubing.

The set-up (Fig. 1) has of course been prepared in advance. It consists first of a container, preferably graduated, filled with the anesthetic agent; a narrow salvasan tube, graduated by 10 cc., has been found most satisfactory. To the bottom opening of the container is attached the infusion tubing, from which the air has been carefully expelled by the column of fluid. The tubing, which is controlled by a screw, has in its middle the usual Murphy glass chamber, which allows visualization of the rate of flow. Maintenance of dosage is discussed below; it is sufficient to say here that the rate of flow usually required is about 12 drops per minute of either 2 per cent procaine or 1½ per cent metycaine.

The misplacement of the caudal needle anterior or posterior to the caudal canal is shown in the roentgenograms. The former error may be eliminated by rectal examination. The latter misplacement is by far the commoner. The needle may slide readily along the posterior surface of the sacral bone, where the dead space may receive the fluid under pressure of injection without too great tension. (However, it will not receive fluid under pressure of the drip.) Because of the depth, the resultant fluid tumor may not be readily palpable at the surface. An experienced operator will differentiate the ease at which the fluid flows by injection with a syringe into and posterior to the caudal canal. Numbness or mild pain down the legs is one of the best signs that the needle is placed correctly in the canal.

After continuous drip had been established, the level of procaine in the graduated container was noted each hour; the

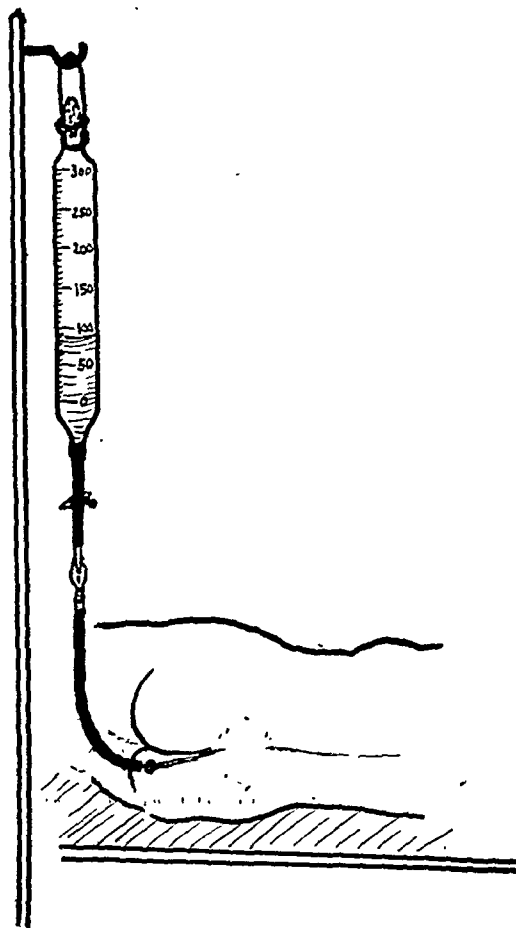


FIG. 1. The graduated container (Vitax No. 4010) hangs from a stand, and is connected by means of ordinary infusion tubing, which includes a Murphy drip chamber, to either a spinal tap needle (B-D Yale-196-2½") or a ureteral catheter, placed in the caudal canal. About thirty minutes after the initial caudal injection has been effective, the infusion is begun at about 12 drops per minute (45 cc. per hour). The rate of flow is regulated by opening, or closing the stop cock on the infusion tubing, or varying the height of the container of procaine.

rate of flow was often varied intentionally in order that we might observe the required maintenance dose in different patients and in the same patient during the progress of labor. We made various other observations, as stated above. An analysis of our data is presented herewith.



## RESULTS

The 130 patients included seventy-three primiparas and fifty-seven multiparas. The types of deliveries and operative procedures were: precipitate delivery four, spontaneous delivery thirty-four, low forceps fifty-one, mid forceps twenty (Kielland fourteen, DeLee two, DeWees axis traction two, manual rotation and mid forceps two), breech extraction two, uterine tamponade two, Pomeroy sterilization two, cesarean section one. The success of these caudal blocks is shown in Table 1. It should be stated that some selectivity was used. When several patients were available and only one caudal possible, the woman with the most obvious hiatus was chosen.

TABLE 1  
RESULTS OF 130 CAUDAL BLOCKS

	Failure, Partial Success or Needle into Dura	Success, but Stopped before Delivery	Success, Including Labor and Delivery
Single injection	11	3	36
Fractionally continuous drip	2	4	6
Continuous drip	1	12	55
	14	19	97

The reasons for discontinuation of a successful caudal block before delivery were: no attendant to watch overnight two, unsuccessful manual dilation for a partially dilated cervix one, procaine excitement three, nembutal excitement one, suspected cephalopelvic disproportion one, patient not in labor one, patient's request one, needle out of place two, blocked needle one, leak in rubber tubing one, excessive fall in blood pressure one, severe pain in legs one, excessive vomiting one. These cases are discussed below.

*Amount of Anesthetic Required for Initial Dose.* The amount of 2 per cent procaine required for a full initial effect was from 40 to 50 cc., generally about 45 cc.; 30 to 35 cc. of 1½ per cent metycaine were usually

needed. By full initial effect is meant the composite of: (1) skin anesthesia of the perineum and contiguous areas, usually up to the level of the umbilicus; (2) perineal relaxation, including the external anal sphincter; and (3) complete obstetric analgesia. The initial dosage includes the test dose of 6 cc. of 2 per cent procaine or 8 cc. of 1½ per cent metycaine.

While the figures of 45 cc. of 2 per cent procaine and 30 cc. of 1½ per cent metycaine represent the initial dose in the majority of cases, there was some bizarre variation. Table II shows the required initial dose correlated with the stage of labor in 103 cases, eighty-eight with procaine and fifteen with metycaine.

The metycaine series of fifteen cases cannot be considered significant. Twelve patients, or 80 per cent, required an initial dose of less than 50 cc.; nine patients, or 60 per cent, needed from 30 to 35 cc.

From Table II we observe that in seventy-seven of the eighty-eight procaine cases, or 87.5 per cent, the initial dose was 50 cc. or less; in seventy-one cases, or 80.7 per cent, the initial dose required was from 40 to 50 cc.; thirteen patients needed an initial dose of more than 50 cc., and four of these required 100 cc. or more. It must be realized, of course, that these amounts were not administered in single injections, but fractionally. If the ordinary initial injection of about 45 cc. of 2 per cent procaine produced the usual perineal relaxation, accompanied by skin anesthesia of the perineum but not of the lower abdomen, and only partial obstetric analgesia, small doses were repeated at intervals until complete obstetric analgesia was obtained. The time required is discussed elsewhere. It is probable that the anatomy of the sacrum of these refractory patients allowed the escape of procaine into the surrounding soft tissues. Thus an additional amount was needed initially to saturate these tissues before the anesthetic agent could rise to the level of the tenth dorsal segment. However, after the initial effect had been obtained, the average maintenance dosage sufficed.

Strangely, in a few cases in which obstetric analgesia was secured, the level of skin anesthesia did not reach the umbilicus. Although one cesarean section was successfully performed with a minimum of blood loss, two postpartum abdominal sterilizations proved refractory. We have discarded caudal block as too unreliable for abdominal surgery. In a busy operating room running on schedule, it is impractical to encounter the occasional refractory cases which require an additional half hour before the full initial effect is obtained. Other anesthetics are more dependable.

of the second injection and the establishment of the full initial effect is termed the latent period.

Table III shows the latent period in ninety cases correlated with the initial dose required. In seventy-two of the ninety cases, or 80 per cent, the full effect was obtained within fifteen minutes, all with a dose of not more than 55 cc. In forty-three, almost half the cases in which the latent period was recorded, the latter was five minutes or less. The higher latent periods are associated with the higher initial doses. These are the cases discussed above in

TABLE II  
REQUIRED INITIAL DOSE CORRELATED WITH STAGE OF LABOR

Dilation	Initial Dose in Cc.													
	25	30-33	35-36	38	40-43	45-47	50	55-57	60	65	70	100	130	195
Full	1	1			16	11 1 m.*	7	1	1		1			
3 4 f		1 2 m.	1 m.	1	8 1 m.	7 1 m.	6			1	1	1		1
1-2½ f		6 m.	2		12		3	1	1 m		1 m.		1	
Not in labor							1			2				
Total procaine	1	2	2	1	36	18	17	2	1	3	2	1	1	1
Metycaine		8	1	0	1	2	0	0	2	0	1	0	0	0
Grand total	77 procaine plus 12 metycaine						11 procaine plus 3 metycaine							

\* Figures followed by m refer to metycaine series

*Latent Period between the Time of Injection and the Full Initial Effect.* As previously stated, initial effect means full obstetric analgesia, accompanied by both perineal relaxation and perineal skin anesthesia, usually reaching as high as the umbilicus. The latent period is recorded from the time of completion, not of the test dose of 6 or 8 cc., but of the next injection of 25 to 35 cc., given ten minutes later, from which the full initial effect is expected. If the latter is not so produced, small fractional doses (5 to 10 cc.) are given at intervals until the full effect is achieved. The total amount injected before the full initial effect is obtained is termed the initial dose. The time interval between the completion

which caudal block, though effective, is impractical for abdominal surgery because of the time element. As yet we have no method of prognosticating this condition.

*Duration of Labor.* The duration of the remainder of the first stage of labor after caudal block had become effective was recorded in fifty-six cases. These are classified in Table IV according to parity and dilation of the cervix at the time of the initial effect. Thus the average of the remaining first stage after the institution of caudal block was three hours and fourteen minutes. As expected, it was less for the more advanced cases. The longest remaining first stage was eight and one-half hours; caudal in this case was begun when the cervix was one

finger dilated and thick, but effaced; the patient, a primipara, had received 505 cc. of 2 per cent procaine in nine and a half hours. The earliest stage in which caudal was begun was in a primipara whose cervix was one finger dilated and incompletely effaced; the remaining first stage lasted seven and one-half hours; the patient had received 448 cc. of 2 per cent procaine in nine and one-fourth hours. The average duration of the second stage for twenty-four primiparas was one hour and sixteen minutes, and for twenty-five multiparas fifty-six minutes.

TABLE III  
LATENT PERIOD IN 90 CASES

Initial Dose in Cc.	Latent Period in Minutes									
	5 or Less	6-10	11-15	16-20	25	30	35	45	80	90
25	1									
30-33	2 m.*	4 m.	3 m.	2 m.						
35	1	2								
40	17	3	1 m.							
45	9	4	4		1					
		1 m.								
48-50	12	3	1	1	1 m.					
55	1	2	1		3			1		
60					1	1 m.				
70					1	2	1	1		
130										1
195										1
Totals	43	19	10	3	6	4	1	2	1	1
	72 (61 procaine and 11 metycaine)			18 (16 procaine and 8 metycaine)						

\* Figures followed by m. refer to metycaine series.

In Table v the total duration of the first stage is classified according to parity and dilation of the cervix at the time caudal block was begun. We see from the table that with two exceptions there was a graduated increase in the *total* duration of the first stage the later caudal was instituted. For twenty-eight patients, of whom sixteen, or 57 per cent, were primiparas, in whom continuous caudal analgesia was inaugurated before the cervix had reached three finger dilation, the average total first stage was eleven hours, fifty-seven minutes.

For thirty-one patients, of whom seventeen (55 per cent) were primiparas, in whom the cervix was at least three fingers dilated when caudal block was begun, the average total first stage was twelve hours, fifty-five

TABLE IV  
AVERAGE DURATION OF REMAINDER OF FIRST STAGE AFTER CAUDAL BLOCK

Dilation at Institution of Block	Parity		Average
	Primiparas	Multiparas	
1-1½ fingers	6 h., 53 m. (8 cases)	2 h., 45 m. (2 cases)	5 h., 57 m. (10 cases)
2-2½ fingers	3 h., 18 m. (14 cases)	3 h., 26 m. (8 cases)	3 h., 21 m. (22 cases)
3-4 fingers	1 h., 45 m. (10 cases)	2 h. (13 cases)	1 h., 53 m. (23 cases)
			3 h., 14 m. (55 cases)

minutes. This difference of one hour does not appear too significant. However, it may be mentioned that the figures for the duration of "total first stage," in contrast to "remaining first stage," are dependent in part on the history obtained from the

TABLE V  
AVERAGE DURATION OF FIRST STAGE

Dilation at Institution of Block	Parity	
	Primiparas	Multiparas
1-1½ fingers	14 h., 6 m. (5 cases)	7 h., 30 m. (3 cases)
2-2½ fingers	12 h., 19 m. (11 cases)	12 h., 15 m. (9 cases)
3-4 fingers	16 h., 23 m. (9 cases)	9 h., 13 m. (11 cases)
Full	15 h., 9 m. (9 cases)	10 h., 10 m. (3 cases)

patient, a not too reliable source of information.

*Effect on the Cervix and on Uterine Contractions.* We did not observe that continuous caudal block had any effect on the duration, intensity or frequency of uterine contractions. This is to be expected since the motor nerves of the uterus come off at

a level above the tenth dorsal segment, the upper limit to which the anesthetic usually rises. From this fact we may draw the

and twenty-four minutes for fifty-three cases in which 2 per cent procaine was used and one hour, fifty-eight minutes for seven



FIG. 2.



FIG. 3.

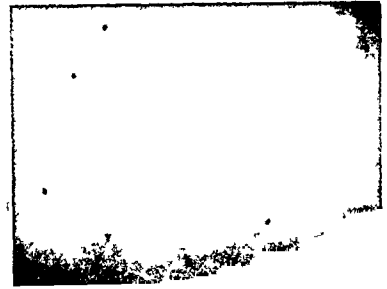


FIG. 4.

FIG. 2. Illustrates the posterior misplacement of the intended caudal needle. This error is the more frequent type, but sometimes not readily detected.

FIG. 3. Illustrates both the posterior and anterior misplacements. The latter is infrequent and is readily detected, or its possibility easily eliminated by routine rectal examination.

FIG. 4. Illustrates the needle correctly placed in the caudal canal.

corollary that sufficient relaxation cannot be obtained from caudal block for the execution of an internal podalic version; we failed in one such attempt. Similarly, although we have performed breech extraction under caudal drip, greater relaxation is obtained with general anesthesia.

The relaxing effect of caudal block on the cervix cannot be denied. The cervix has a characteristic soft, mushy feeling, palpable even on rectal examination.

In this regard, one interesting experience is worth mentioning. A primipara was placed on the table for delivery with the cervix two and one-half fingers dilated, mistakenly diagnosed as fully dilated. The vertex was in mid pelvis in a transverse position. Manual dilation was attempted only because of scientific curiosity. Full dilation was accomplished with surprising facility within a few seconds; the cervix seemed to melt. Delivery was readily accomplished with Kielland forceps. Examination of the cervix ten days postpartum revealed no abnormalities.

*Continuation of Caudal Effect after Discontinuation of the Drip or after a Single Injection.* The average time for the persistence of the after-effect was one hour

metycaine cases, or one hour, twenty-eight minutes for all sixty cases, including seventeen single injections. There was a variation in this time of from fifteen minutes to three hours. However in forty-eight cases (forty-two procaine and six metycaine), more than three-fourths of the sixty cases accurately studied, this time was at least one hour. In thirty-nine cases of continuous caudal block, the after-effect likewise lasted at least an hour.

Of twenty-one cases (eighteen procaine and three metycaine) in which single injections of amounts ranging from 25 to 70 cc. were administered, the duration of caudal effect was as follows: from thirty to forty-four minutes in two cases, from forty-five minutes to one hour in four cases, from one to one and one-half hours in three cases, from one and one-half to two hours in nine cases, from two to two and a half hours in two cases, and between two and a half and three hours in one case.

*Motor Paralysis of Lower Extremities.* We have found motor paralysis of the legs more frequently among the continuous caudals of longer duration, and we have interpreted this as a result of prolonged caudal block and constant bathing of the

motor nerves, or as an early sign of overdosage. While the latter explanation was generally consistent with the other facts, in a few cases this was not so.

Motor paralysis of the lower extremities was observed in thirteen cases, in two of which metycaine was used. The duration of the paralysis was usually from thirty to forty-five minutes; in two cases it lasted two hours. In both of these the caudal effect after discontinuation of the drip was also extended, that is, to three hours. We noticed no after effects in any of these cases of temporary paralysis.

*Blood Pressure.* In only one instance was the drip discontinued because of a marked fall in blood pressure; this was one of the few cases in which the original blood pressure was elevated.

**CASE 1.** A twenty-four year old para II was one finger dilated, with a thick, uneffaced cervix, when caudal block was begun. The pains were five minutes apart, lasting two minutes, and blood pressure was 160/95. Analgesia became effective after the initial injection of 45 cc. Although the contractions were painless, the patient was troubled by continuous umbilical pain, not previously present, and by an uncontrollable desire to defecate. Despite having had an enema and a cathartic, she voided and defecated over herself, but not over the caudal area. The needle was left in place while she was cleansed, the bed changed and the caudal area repainted. Mild pains returned forty-one minutes after the initial injection; 35 cc. of 2 per cent procaine were given fractionally within about twenty-five minutes. While the contractions again became painless, the umbilical discomfort persisted. Continuous drip was then instituted. One hour after the initial injection, the blood pressure had fallen from 160/95 to 130/90; one hour after this it was 85/50. The drip was discontinued although the pulse was good, 86/minute, and the patient had no complaints. She had received a total of 131 cc. of 2 per cent procaine in two hours. The cervix was still one finger dilated, but effaced. The umbilical pain, which had disappeared, returned one hour after the discontinuance of the drip; by this time the blood pressure had risen to 110/80. Five hours after the cessation of the

drip, blood pressure was 130/85; it remained at this level. Four days postpartum the pressure was 130/75 and the patient was in good condition.

Among the cases in which procaine was used, the blood pressure was followed in thirty-four. Twenty-one showed some change, with systolic drops ranging from less than 20 to as great as 80 mm. Hg, and diastolic alterations from a depression of 45 points to a rise of 20. In one case there was no initial change in systolic pressure, but a secondary rise of 20 points; diastolic pressure was unaffected.

Of the fifteen metycaine cases, two revealed no alteration and two showed a rise of 15 mm. Hg, both systolic and diastolic. Of the eleven remaining cases, the greatest depression was 40 points systolic and diastolic, with a spontaneous return to normal during the drip. The other systolic depressions varied between 40 and 15 points; the corresponding diastolic pressures were unchanged or dropped as much as 40 points.

*Complications.* The following side reactions were observed: excitement and disorientation in nine cases, chills in four, burning in five, nausea and vomiting in eight, dizziness in three, nonuterine pain in ten, uncontrollable desire to defecate in one, unilateral anesthesia of the perineum in two. There were no infections or broken needles. Motor paralysis and blood pressure variations have already been discussed, as was the one patient complaining of fecal incontinence.

Of the excitement cases, seven were classified as mild. Of these seven patients, one suffered visual hallucinations; one was unable to see for three or four minutes; one patient after only 46 cc. mimicked everything she heard for about half an hour during and after delivery, which occurred immediately after caudal block; one patient was definitely disoriented and stated she realized she was "talking out of her head" and felt that she was going to die; three patients showed definite mild excitement. Of these last, one bout was the result of too

large an initial dose and another was due to the unintentional intravenous injection of part of the initial dose. Although no blood or fluid was obtained on aspiration before injection, the needle was rotated during injection and apparently thus broke into a contiguous vein, which it was probably just touching previously. Aspiration after injection of part of the initial dose produced blood, and the needle was withdrawn; excitement followed almost immediately. After this experience we rotated all needles 360 degrees just before aspiration and injection. The third case of moderate excitement followed the injudicious injection of the small amount of procaine remaining in the container after an adequate continuous caudal had been maintained to visible caput. Excitement, which took place after the patient's transfer to the delivery table, was controlled by  $7\frac{1}{2}$  gr. of sodium amytal given intravenously. The mother received oxygen inhalation for twenty minutes, after which a low forceps delivery of a normally crying infant was performed. Recovery was uneventful.

Four patients had transitory shaking chills soon after or remotely after the initial injection. Four patients complained of a severe burning sensation following rapid injection. Three patients were troubled with dizziness; one of these states was expressed as "seasickness." Nausea, vomiting or both occurred in eight cases; in one case emesis was so severe that caudal had to be discontinued.

Ten women suffered non-uterine pain. Five had pain down their legs during contractions, more intense than the commoner numbness down the legs. Two mentioned pain running up the spine, and one pain running bilaterally from the caudal area. In one case a pre-existing headache was aggravated. One patient reported severe pains in both thighs accompanying uterine contractions.

There were two fetal deaths, including a three pound stillbirth; the other death accompanied intrapartum maternal mortality.

CASE 11. A nineteen year old para O, gravida 1 was admitted in labor with the cervix one finger dilated, soft, thick and effaced. Caudal block with 2 per cent procaine was given as follows: 8 cc. at 3:20 P.M., 10 cc. at 3:22 P.M., and 32 cc. at 3:27 P.M. The full initial effect was obtained by 3:35 P.M., and continuous caudal drip was set up at 4:05 at the rate of 12 drops per minute. The patient vomited at 4:30. The blood pressure, which had been 135/70 on admission, was 100/55 at this time. Caudal block was discontinued at 5:35 P.M., when the patient was found in a semicomatose state, with twitching of her arms. She was given coramine and placed in a Drinker respirator; at 8:00 P.M. she was pronounced dead. After the initial injection, which amounted to 50 cc., she had received an additional 65 cc. of procaine by the continuous drip method, a total of 115 cc. We believe that death was due to the use of a long needle, incompletely buried, which accidentally pierced the dura when the patient moved about. It is significant that the management of this case was the exception to our routine, i.e., of definitely assigning the responsibility of each patient to a specific individual.

*Maintenance Dosage, with a Discussion on the Mechanics of Regional Anesthesia.* Caudal anesthesia is local anesthesia on a grand scale. The anesthetic, after entering the sacral canal through the hiatus, rises extradurally to the level of the tenth dorsal segment; it then seeps out through all the intervening vertebral foramina to act on the nerve trunks after they have lost their dural sheaths. The desired clinical result is due to the action of the anesthetic agent at these local sites (the nerves involved). The systemic reaction, including toxic effects, is caused by the absorption of procaine into the circulation.

The precise mechanism of the local action of procaine on the nerve trunks may be formulated as follows: The procaine enters into an unstable physicochemical combination with the nerve substance<sup>5</sup> to form a protoplasmic poison which prevents the conduction of impulses. Thus:

Procaine + nerve lipid

$\rightleftharpoons$  protoplasmic poison

This end product is unstable, and a reversible reaction results. The velocities of the opposing reactions will depend upon the amount of reacting substances present, in accordance with the chemical law of mass action. As the original combining reaction proceeds, more protoplasmic poison forms, increasing the speed of the reversible reaction. Eventually the velocities of the two opposing reactions will be equal, and equilibrium will be established. The constant amount of protoplasmic poison present when equilibrium is reached will depend upon the velocity of the reaction at this time; this in turn depends upon the amount of free procaine present.

Thus a certain critical concentration of free procaine must be present to maintain the equilibrium between the opposing reactions at such a point that the amount of protoplasmic poison necessary to produce clinical anesthesia is present. This hypothesis is consistent with the findings of Lemmon and Paschal,<sup>6</sup> who stated that a certain concentration of procaine must be maintained in the cerebrospinal fluid to produce spinal anesthesia.

This hypothesis is also consistent with the experiments on a ligatured limb in which cocaine was not destroyed but recovered as such after several hours.<sup>7</sup> Thus procaine entering into combination to achieve anesthesia is again utilizable after this labile combination has broken down.

It is, therefore, evident that the procaine engaged in local action about the nerve is present in both a combined form and a free form. The combined form is the effective substance which produces the desired clinical result. However, a certain critical amount of the free form is necessary to maintain the required concentration of the combined form in a reversible chemical equilibrium.

To produce the initial effect of caudal block, in addition to the sum of the amounts necessary for these two factors, an amount (probably about one-third of the initial dosage) is needed to act as a vehicle, that is, to carry or push the essen-

tial amount of procaine from the point of the needle in the sacral hiatus to all the nerves outside the vertebral foramina as high as the tenth dorsal segment. Thus, after the initial injection, the free procaine will consist of two portions, one necessary for the maintenance of the combined form and the other useful mechanically but not chemically.

It must be realized that the procaine will not be uniformly distributed in the vertebral canal; concentration is highest at the point of the needle and decreases with the distance from this point. To be effective, the amount of procaine in a region must be equal to the amount,  $c$ , needed to combine with the nerves, plus the minimal free amount,  $F_c$ , required to maintain this combination. In addition, there will be an excess free amount,  $f$ , as a result of vehicle requirement. This amount,  $f$ , diminishes with the distance from the needle point and is minimal at the upper level of caudal anesthesia. The disappearance of excess free procaine,  $f$ , and the fall of total free procaine,  $F$ , below  $F_c$  is manifested clinically by the first signs that the caudal effect is wearing off. This should occur where  $f$  is least, that is, at the upper level of anesthesia.

If the rate of absorption of procaine is directly proportional to the concentration of procaine present, both of which must be changing continually, we may express these facts mathematically according to the law of inverse compound interest. By the use of the differential calculus:

$$k \frac{dA}{dt} = F - A$$

where  $A$  is the amount absorbed after any variable time  $= t$ , and  $F$  is the amount of free procaine initially present, *i.e.*, the difference between the initial dose and the amount of combined procaine.

The algebraic solution is:

$$A = F \left( 1 - \frac{1}{e^{t/k}} \right)$$

where  $e$  is the natural number 2.71828. . . . If  $A$  is to represent the amount absorbed in any particular region, the proportionality constant,  $k$ , will depend only on the vascularity and vascular state of that region. If  $A$  is to represent the overall absorption,  $k$  will be constant for a particular type of injection in a patient. The above expression will govern the absorption during fractionally continuous caudal,  $F$  representing then the free procaine at the onset of each injection.

If after the initial injection a continuous drip is set up at a constant rate,  $m$ , we may state:

$$\frac{dA}{dt} = F + mt - A$$

from which it follows that:

$$A = mt + (F - mk) \left( 1 - \frac{1}{e^{t/k}} \right)$$

This expresses the amount absorbed only during the drip.

If the rate of inflow were to be made equal to the rate of absorption, it may be shown that both would then be equal to  $\frac{F}{k}$ . Our particular system precludes this contingency, however. Replacement of absorbed procaine is indirect and, as stated, an additional vehicle rerequirement is essential to convey the procaine from the point of the needle to all points where absorption is occurring. It is this vehicle portion which is responsible, at least in part, for the continuation of the caudal effect at the lower levels after its wearing off at the higher levels, and for longer periods associated with the longer caudal blocks. It is conceivable that the fractional method might accomplish replacement of absorbed procaine at the upper level of the block more efficiently with less vehicle requirement, at least during the earlier stages of the block.

From the above conclusions, all based on our original premises, the following corollaries have been derived: Absorption be-

gins immediately and goes on continuously, its rate never constant. A good deal of procaine must be absorbed without ever entering into the protoplasmic combination to produce anesthesia or without even serving the useful function of maintaining that combination. Again, as explained above, anesthesia should wear off first at the uppermost level, where excess procaine is minimal. It is the absorbed procaine of this region that must be indirectly replaced. If procaine is added as soon as the caudal effect begins to wear off, only a small amount is necessary to maintain the anesthetic level. If this level is allowed to fall, however, the amount of free procaine will fall much below the required critical level in a large region, and considerably below at the desired upper level. Regaining the original level of anesthesia will now be a much more difficult problem.

#### SUMMARY

1. One hundred thirty cases of caudal block are analyzed, of which fifty were single injections; of the remaining eighty, twelve were fractionally continuous and sixty-eight were of the continuous drip type.

2. Ninety-seven cases were wholly successful. In nineteen cases block, though effective, was discontinued before delivery, and in fourteen cases there was complete or partial failure or the dura was penetrated.

3. The continuous drip technic presented in a preliminary report<sup>1</sup> is described and its advantages reviewed.

4. The operative procedures and deliveries included four precipitate and thirty-four spontaneous deliveries, fifty-one low forceps, twenty mid forceps, three breech extractions, two uterine tamponades, two abdominal sterilizations and one low flap cesarean section.

5. The amount of 2 per cent procaine required for full initial effect was usually 45 cc., and of 1½ per cent metycaine 30 to 35 cc.

6. Full initial effect was obtained within fifteen minutes in the majority of the cases,



and within five minutes in one-half the cases.

7. Thirteen cases were refractory, that is, the usual initial dose produced only a partial effect, namely, perineal relaxation, skin anesthesia of the perineum and only the lowermost part of the abdominal wall, and only partial obstetric analgesia. Small doses were injected at intervals until complete analgesia was obtained. After this initial effect had been acquired, only an average maintenance dose was needed.

In these patients, the anatomy of the sacrum probably allowed the escape of procaine into the contiguous soft tissues; after these had been saturated, the anesthetic agent could rise to the required level of the tenth dorsal segment and thence seep out through the sacral foramina and act upon the nerves of the uterus and of the abdominal wall below the level of the umbilicus.

8. It is the occasional refractory case with its additional time requirement that makes caudal block unreliable for abdominal surgery, particularly in a busy operating room running on schedule. We did, however, perform a successful cesarean section under caudal, with surprisingly small loss of blood.

9. There is definite softening and relaxation of the cervix, palpable even on rectal examination. The uterus is not affected; contractions are therefore unchanged, as we have found. Due to this lack of relaxation, version under caudal block is undesirable and breech extraction is preferable under general anesthesia.

10. There is an apparent shortening of the first stage of labor. The average duration of the remaining first stage after initial effect was three hours, fourteen minutes in fifty-five cases, with a maximum of eight and one-half hours. A gradual increase, however, was observed in the total duration of the first stage the later caudal block was instituted.

11. The average duration of the second stage was one hour and sixteen minutes for twenty-four primiparas, and fifty-six min-

utes for twenty-five multiparas. The large number of forceps deliveries, many of which were prophylactic, must be considered when one weighs these figures.

12. Caudal effect after discontinuation of continuous drip or after single injections persisted for an average of one and one-half hours in sixty cases. The variation was from fifteen minutes to three hours, with the majority at one hour.

13. Temporary motor paralysis of the lower extremities was noted in thirteen cases. It usually lasted about one-half to three-quarters of an hour, duration being roughly correlated with the persistence of caudal effect after discontinuation of the drip. Observations in most cases were consistent with the interpretation that paralysis is an early sign of overdosage or a result of prolonged continuous block.

14. In only one case was the drop in blood pressure great enough to necessitate discontinuance of the drip. A pre-eclamptic multipara with an initial blood pressure of 160/95 showed no general symptoms accompanying a fall to 85/50 in two hours; blood pressure rose to a constant level of 130/85 five hours after the caudal drip had been terminated.

15. Among the forty-nine cases in which blood pressure was carefully watched, thirty-one showed some depression; in eighteen cases the systolic fall was at least 20 points.

16. There were two fetal deaths in our series. One three pound infant was still-born; a report is given of the case in which both mother and child died.

17. The use of a short needle, or preferably the catheter technic, eliminates the possibility of the penetration of the dura by a long needle, not buried up to the hillock. The accidental pushing of the needle too far into the caudal canal when the patient moved was, we believe, responsible for her death.

18. Other complications included nine cases of excitement and disorientation, ten of nonuterine pain, four of chills, five of burnings, eight of nausea and/or vomiting,

three of dizziness, one of an uncontrollable desire to defecate, and two of unilateral anesthesia of the perineum.

19. A conception of the mechanics of regional anesthesia is presented.

#### CONCLUSIONS

Any method which produces such complete and dramatic obstetric analgesia cannot be dismissed because of certain disadvantages and inconveniences to the physician. The disadvantages may in time be eliminated by continual modification of technic. Although continuous caudal analgesia is still in an experimental stage, we maintain confidence in its eventual destiny

as an addition to our obstetrical armamentarium. In its present state, however, its inherent disadvantages obviate its universal use, and thus preclude its acceptance as the long awaited panacea.

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In the overwhelming majority of cases laceration of the genital canal are due to childbirth, but other forms of trauma, such as coitus, attempted rape, or external violence may at times be responsible. The cervix and perineum are the usual seats of lacerations of the obstetrical type.

From "Textbook of Gynecology" by Emil Novak (The Williams & Wilkins Company).

# SELF-INFLICTED BITE

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ARTICLES have appeared recently entitled "Morsus Humanus" or "Human Bite," in which very little

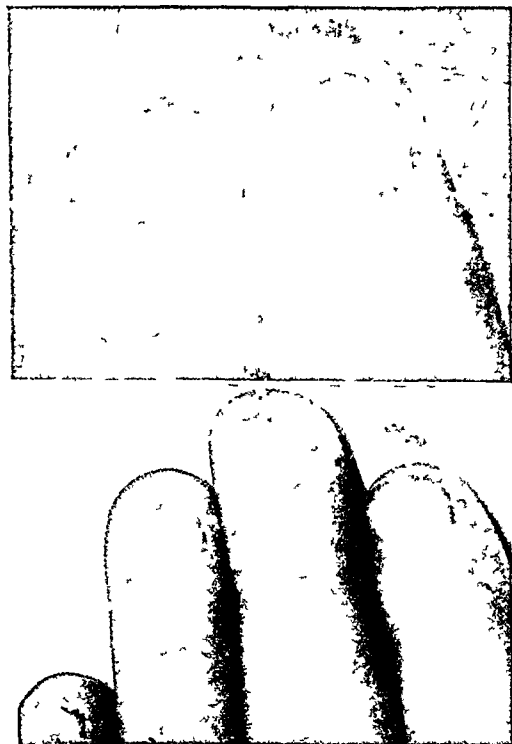


FIG. 1 Showing the common nail biting in a mechanic badly in need of the protection of his nails.

erroneous or no mention at all is made of self-inflicted dental injuries.

Boyce,<sup>3</sup> for instance, quoting a case of an infected finger from nail biting reported by Hultgen in 1910, refers to it as: "the first infection from human saliva not caused by a true bite." In my opinion this bite is as true as the other. It is a homo morsus humanus while the other is a hetero morsus humanus. To say that the infection is due to "saliva" needs to be explained.

The most common form of self-inflicted bite is represented by nail biting. (Fig. 1.)

This is a neurotic symptom irrespective of age, profession or social standing. It can be noticed in mechanics who are badly in need of their nails, in physicians who know of the potential dangers, in debutantes well aware of the social importance of long and shapely nails.

Onychofagia may go from an occasional pulling of the cuticles to a regular daily dinner. Like the play of the policeman's stick, the gum chewing or mouth motions of the aged, it may be mild, but it has the same functional and neurotic significance as the pulling of one's own hair or the hitting of one's head against the wall. In some cases it may be done for pleasure, or for a change from a severe itching to the preferred sensation of pain.

Not all self-inflicted bites are done by feeble minded and not all are without consequence. I recall a case of an intelligent young woman, who, under nervous strain from pain, bit her wrist so hard as to detach the skin. A severe lymphangitis and lymphadenitis followed, which needed considerable medical care.

The state of neurosis is evident in girls and boys with biting marks on their knuckles and thumbs. (Figs. 4 and 5.) They are ready to admit that they do it while at the movies, during moments of great excitement or suspension. These girls do not need an explosion to become excited. One, for instance, just by talking about it had to rush to the toilet. With it often goes the refusal of the throat to swallow pills.

Self-inflicted dental injuries in feeble minded are described by Butterworth.<sup>5</sup> In the discussion, Weidman remarked that monkeys in zoological gardens are frequently seen furiously biting their fingers and toes.

Sucking the toes can be seen in infants. I never thought toe nail biting would be done by adults. A few days ago a stout, seventy-year old woman came to the

finger nails severely bitten. I asked jokingly if she bit her toenails, too. To my astonishment, she answered she did it up to a few years ago.

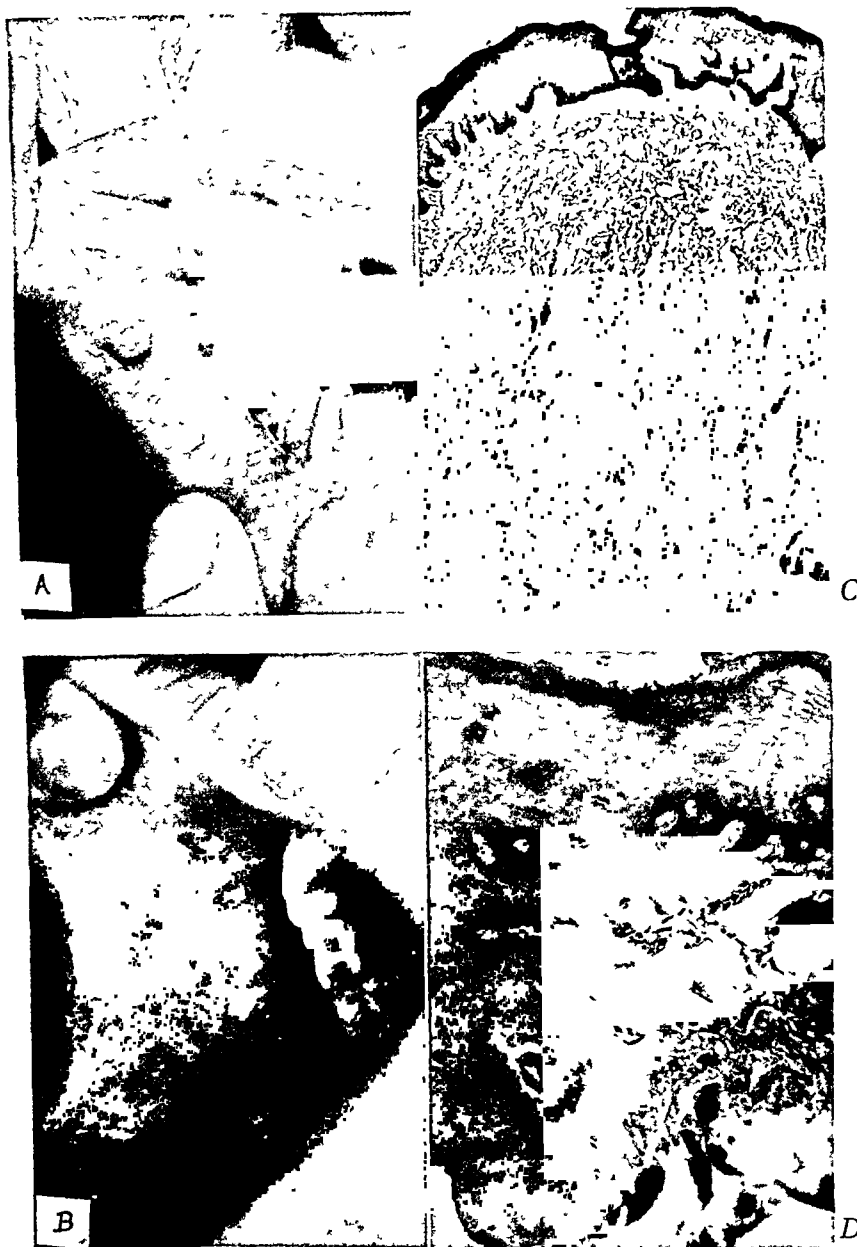


FIG. 2. A, showing a firm nodular lesion on the mucous membrane of the cheek; B, a linear growth along the line of occlusion of the teeth, a common occurrence. In both the histopathology shows hyperkeratosis and acanthosis similar to leukoplakia.

Skin Out-Patient Department of the Rhode Island Hospital for pruritus about the area where a vulvectomy had been performed for pruritus vulvae. I noticed her

Buccal mucous membranes are frequently the site of considerable damage. Raised linear lesions are seen corresponding to the line of occlusion of the teeth. (Fig.

2B.) On the upper or lower lip they look like a patch of leukoplakia or of lichen planus or like a keloidal scar. Some lesions are round and stick out like the head of a pin or as big as a pea. (Fig. 2A.) They are usually smaller in the morning and larger toward night because of the daytime work on them.

Histologic examination (Fig. 2C and D) shows hyperkeratosis, parakeratosis and acanthosis indistinguishable from leukoplakia and as such diagnosed by competent pathologists.

A sequela of infantile self-inflicted bite is represented by a scar below the vermilion part of the lower lip. (Fig. 3.)

Bites during epileptic seizures, if fairly recent, may be important if personal identification is needed.

While nail biting is extremely common (Fig. 1), severe knuckle and thumb biting (Figs. 4 and 5) in apparently normal persons is uncommon and often not recognized. They are often mistaken for warts, keloids, epitheliomas, sarcoid, granuloma annulare or, as in Figure 5, epidermophytosis. Mouth lesions may be mistaken for syphilis or leukoplakia or lichen planus. Obviously, the prognosis of self-inflicted bite is far better than in any of the former disorders.

Figure 2A shows a pea-sized lesion from *homo morsus humanus* on the mucous membrane of the cheek in an apparently normal, intelligent, forty year old woman. Histologically, it shows a fibroma covered by hyperkeratotic and parakeratotic epithelium. Figure 2B shows linear lesions of the mucous membrane of the cheek along the line of occlusion of the teeth, done by a grinding motion in an apparently normal twenty year old girl. Probably, it is only necessary to start and feel something under the bite to continue the job consciously and unconsciously. The microphotograph Figure 2D, taken with higher magnification, shows the same features as the previous one Figure 2C.

Figure 4A and B shows examples of unusually severe one-knuckle biting in two

school boys apparently normal. Why only one knuckle? Why a severe one-knuckle chewing and no damage to the nails? Figure 4C shows the fingers of a mentally deficient boy, seven years old. It can be noticed that he does not attack his indexes from the easiest side, but at the interdigital aspect of the finger, making an effort to rotate the hand and accomplish the task. Why this one spot preference? A local neurosis?

Figure 5 shows the thumbs of a fifteen and of a twenty year old girl, both apparently normal. They believe the physician a mind reader when he tells them that they do it while at the movies and only at the movies.

Nail biting is rarely followed by infection, presumably because of the antiseptic power of the saliva and because of the constant keeping of the parts under its action. The same can be said for bites inside of the mouth.

If after a fight or the fall the injured would suck or lick his wound as a dog would do until medical care is administered, probably no infection would follow. Of course, the extension and severity of the laceration, the dirt, and the individual state of health are contributory factors in the development of the infection.

#### TREATMENT

In spite of several proprietary products advertised as remedies to nail biting, this habit in adults is very difficult to change. Being a neurotic symptom its treatment is fundamentally that of the neurosis.

Nodular growths on lips or cheeks are well taken care of by removal with electrodesiccation and by warning the patient of the potential danger.

Knuckles could be covered with bandage or adhesive plaster. They will not be forgotten, however, until some other symptom is substituted or the fundamental cause of the neurosis is eliminated.

#### SUMMARY

Cases of self-inflicted dental injuries (nail, knuckle, finger, lip, cheek biting) are

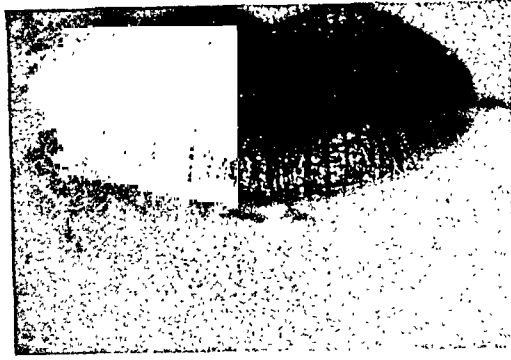


FIG. 3. Showing the scar on the lower lip due to the upper incisors' bite during infancy.

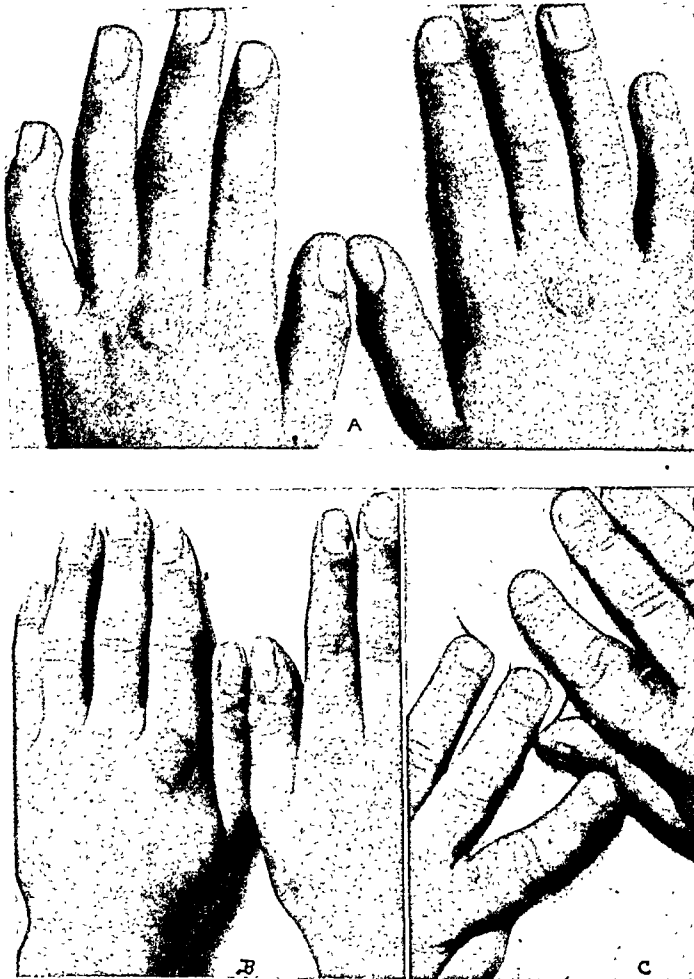


FIG. 4. A, showing a case of two-knuckle biting in a twelve year old normal boy; B, one-knuckle biting in a seven year old normal boy; C, biting of two fingers in a mentally deficient, seven year old boy.



FIG. 5. Showing the thumbs of two normal girls, one fifteen and one twenty years old, who bit their thumbs while at the movies. The condition may be mistaken easily for an eczematoid or mycotic infection, or for a growth. It often goes undiagnosed. Note also mild onychophagia.

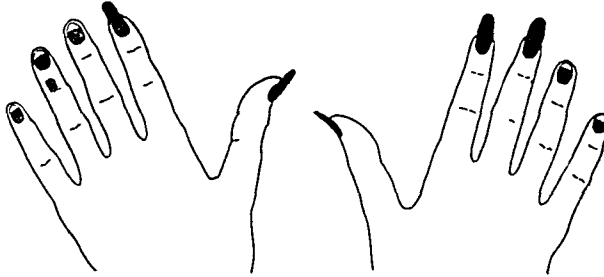


FIG. 6. A peculiar nail biting in a society woman; five nails long, shiny perfectly red-polished and five bitten down to the limit; also bitten distal phalanx of left ring finger.

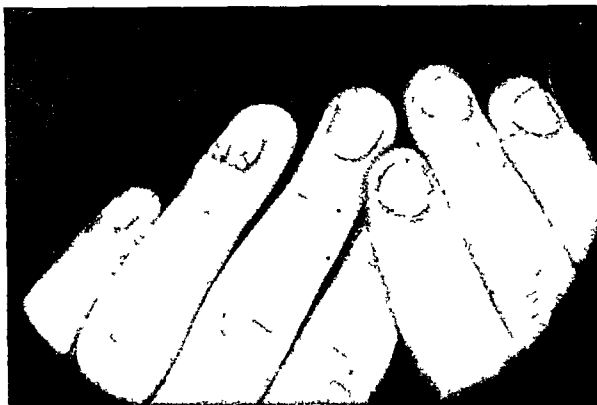


FIG. 7. Absence of one nail and nail bed deformity in a seventeen year old girl, the result of trauma at the age of eleven months. A finger tip pathology of this type is often labeled onychomycosis even if pathogenic fungi are not found. All the nails are bitten off, but the persistent biting and pulling of the cuticles in the abnormal finger tip, causes tenderness, eventually paronychia or a felon. If not bitten, it would be simply a missing nail; a nail anomaly of obscure pathogenesis.

discussed. These cases are true morsus humanus as the bite from one person to another. Methods of prevention and treatment are discussed.

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With the exception of the streptococcal case, established infection of the hand and fingers should receive energetic surgical treatment at as early a stage as possible. Damage may be done, both by delay and by too vigorous and extensive initial treatment, but there can be no doubt that the commoner errors are those of delay and timid surgery.

From "Minor Surgery" edited by Humphry Rolleston and Alan Moncrieff (Philosophical Library).



# CAJANDOL

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A NEW soothing analgesic and antiseptic for the genitourinary system has been developed called cajandol. It is composed of 5 per cent cajeput oil in peanut oil with 0.1 per cent propylparahydroxybenzoate added as a preservative. The therapeutic effect of the preparation is due to the essential oil of cajeput and the oil soluble propyl ester of parahydroxy-benzoic acid. Cajeput oil is an essential oil extracted by distillation from the fresh leaves and twigs of plants of the Myrtaceae family, particularly the species *Melaleuca*, which are commonly found in the East Indies. The preparation was formerly called cagedrol by Elvers and Burkland,<sup>1</sup> but is now being placed on the market by E. R. Squibbs and Sons under the trade name of cajandol. It has a pleasing, medicinal odor and is inexpensive.

We have used cagedrol or cajandol in over 300 cases and have found that it is a very beneficial adjunct in the treatment of irritative and inflammatory lesions of the lower genitourinary tract. These include posterior urethritis in both the male and female, chronic prostatitis, and vesiculitis, acute, chronic and interstitial cystitis and bladder tumor. Cajandol often alleviates the distressing symptoms of these conditions as well as the marked frequency, burning on urination and pain of tuberculous cystitis and the irritation and bladder spasms which at times follow instrumentation of the urethra and bladder. We have found it of particular benefit in chronic urethritis in women for instillation into the bladder after dilatation of the urethra or endoscopy. Its routine use after cystoscopy has led to less discomfort for the patient following this procedure. In those patients who have irritative symptoms and cloudy urine following trans-

urethral resection of the prostate and who are sensitive or resistant to sulfonamide therapy, the instillation of cajandol into the bladder and urethra often leads to rapid cessation of the irritation and to the clearing of the urine of shreds and infection. Cajandol may be injected up the ureter during the use of a ureteral stone extractor to facilitate withdrawal of the instrument when there is difficulty due to spasm of the ureter. The local application of this preparation will also stimulate the healing of tuberculous sinus tracts following nephrectomy or epididymectomy.

We recommend the instillation of 15 cc. to 30 cc. of cajandol into the bladder or posterior urethra through a catheter at daily or bi-weekly intervals. The frequency of administration will depend upon the symptomatology and nature of the disorder present in each individual case. Its effect is usually very soothing on the inflamed mucous membrane of the bladder and urethra. We have never observed any untoward reaction nor had any patient complain of any unpleasantness from its use in the lower genitourinary tract. We believe that cajandol is more efficient than gomenol and is less expensive.

We wish to emphasize that cajandol is not a cure-all, but used in conjunction with established therapeutic procedures in the field of urology, it often affords relief from the distressing symptoms of irritative and inflammatory conditions of the bladder and urethra and prostate. It will often alleviate much of the discomfort which at times follows instrumentation or operation of the lower genitourinary tract.

The following are illustrative cases from our practice in which the alleviation of symptoms followed the instillation of cajandol into the bladder and urethra:

## CASE REPORTS

CASE I. H. M., a forty-two year old white woman, had been having great frequency of urination with urgency and burning for several weeks, found to be due to a severe posterior urethritis. The urine was sterile. Dilatations of the urethra and endoscopy with the application of silver nitrate caused her much distress which was considerably relieved by bi-weekly instillations of 15 cc of cajandol for two weeks and in three weeks her symptoms had completely disappeared.

CASE II. G. S., a sixty-six year old white male, had undergone a transurethral resection for benign prostatic hypertrophy with infected residual urine, but following operation considerable frequency, urgency, and burning on urination persisted due largely to the infection in the urine. He was sensitive to the sulfonamides and it was only after instilling 20 cc. of cajandol into his bladder three times a week for two weeks, that his symptoms disappeared.

CASE III. O. P., a twenty-two year old white girl, had undergone a right nephrectomy for renal tuberculosis, but six months after operation still had marked frequency, urgency and pain on urination due to severe cystitis with ulceration in the bladder. It was only after the instillation of 15 cc. of cajandol into her bladder twice a week for three weeks that marked alleviation of her symptoms occurred. She now gets up at night only once.

CASE IV. T. H., a seventy year old white male, had been treated intermittently for five years for an infiltrating carcinoma of the bladder, which caused him great frequency of and pain on urination. Instrumentation for the purposes of fulguration of the bladder and the application of radium was followed by much discomfort and it was only after the daily

instillations of 15 cc. of cajandol for two weeks that he obtained marked relief from his symptoms and an increase in his bladder capacity.

CASE V. S. G., a forty-five year old white woman, was known to have had interstitial cystitis for two years with marked frequency, urgency, and suprapubic pain. She underwent periodic fulguration and dilatation of her bladder with some relief of symptoms, but obtained more alleviation when the treatment was followed by the instillation of 20 cc. of cajandol into the bladder, daily for a week after the fulguration.

## SUMMARY

A new compound, called cajandol, is now being offered to the medical profession to aid in the treatment of irritative and inflammatory conditions of the lower genitourinary tract. It has been used in many clinical cases and has proved to be a soothing analgesic and a mild antiseptic. It is not considered as a cure-all, but a useful adjunct along with other well established therapeutic procedures for the relief of the distressing symptoms of urethritis in the male and female, general cystitis, interstitial cystitis, prostatitis and some cases of tumor of the bladder. After instrumentation of the urethra and bladder, it tends to make the patient more comfortable. No reactions or aggravation of symptoms in any patient has been noted from its use. It is economical.

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# INGUINAL HERNIA IN INFANTS AND CHILDREN

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**P**RACTICALLY all the inguinal hernias occurring in infants and children are indirect and on the congenital basis of a preformed sac.

An indirect inguinal hernia occurring

In our series there has been an occasional case of femoral hernia so that one should carefully examine these children pre-operatively to make sure whether the defect is above or below Poupart's ligament.

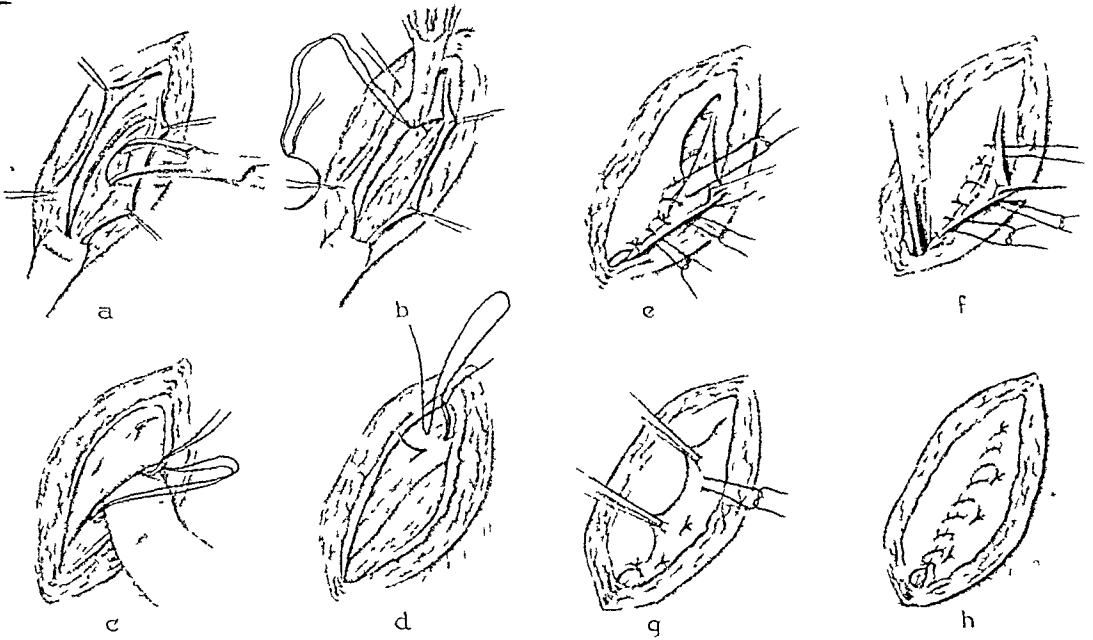


FIG. 1. *a*, Showing external oblique fascia incised and reflected. The curved fine pointed hemostat is separating the cremasteric muscle fibers to expose the sac. *b*, High transfixion and ligation of the sac after its dissection. *c*, Transplantation of the neck of the sac, both ends of suture being threaded through the needle and the suture placed with the finger as a guide. *d*, One end of the suture unthreaded and a small bite of muscle taken with the other before tying. *e* and *f*, The edge of the external oblique fascia is sutured to Poupart's ligament, alternating interrupted cotton sutures placed from the inside and outside of Poupart's ligament. The needle holder is used to determine the proper size for the new external inguinal ring. *g* and *h*, The reflected edge of the external oblique overlapped and sutured with a continuous chromic catgut suture.

or lasting after one year of age should be treated by surgery in the absence of special contraindications. Before the first year of life many of these hernias will automatically close if supported by a yarn truss. Even during this period, if the defect is very large or there is danger of incarceration or obstruction, or if the yarn truss fails to hold back the hernia, surgery is indicated at any age.

In the repair of indirect inguinal hernia there are certain important considerations. The complete and high removal of the sac is very important. The neck of the sac should also be transplanted by the Kocher method. It is not desirable to transplant the male cord because the vas is an extremely small structure in infancy and early childhood, often being no larger than a good sized silkworm gut

suture. If the cord is transplanted, it is readily possible to traumatize the vas and its vascular supply. One can easily find and isolate the sac by splitting the cremasteric muscle fibers longitudinally or parallel with their fibers. The sac is always anterior to the cord. The distal end of the sac should be dissected with sharp dissection as gauze dissection at this stage is very apt to damage the fragile vas and its blood supply.

The repair is done by a modified Ferguson technic, using interrupted single cotton sutures for the lowermost layer which brings the medial edge of the external oblique fascia to the reflected edge of Poupart's ligament. The lateral edge of the external oblique is then sutured with fine continuous chromic catgut. The exit for the cord is left close to the pubis and the size of the new ring is made just big enough to admit the tip of an ordinary needle holder.

In infants and children who are still likely to wet their dressing a waxed paper dressing is applied over the regular dressing, sealing the lower edge and two sides with adhesive tape but being sure to leave the upper end open or otherwise the wound will sweat.

Twelve days is sufficient to keep hernia patients recumbent. In the Doernbecher Hospital cases done by me personally there has been no recurrence, as far as can be determined, including a follow-up on an entire five-year group.

The only difference in the operation in the female child is that there is not the necessity for such great care in the dissection of the sac, inasmuch as, if the round ligament is in the way, it can be cut and re-attached to the fascia anywhere. Also there is no necessity, of course, for leaving an opening for the cord as there is in the male.



# Case Reports

## INTRATHORACIC MEDIASTINAL LIPOMA

MAJOR THOMAS B. WIPER      AND      CAPTAIN JOSEPH M. MILLER  
MEDICAL CORPS, ARMY OF THE UNITED STATES

A LIMITED variety of tumors occur in the mediastinum, many of them defying preoperative diagnosis.

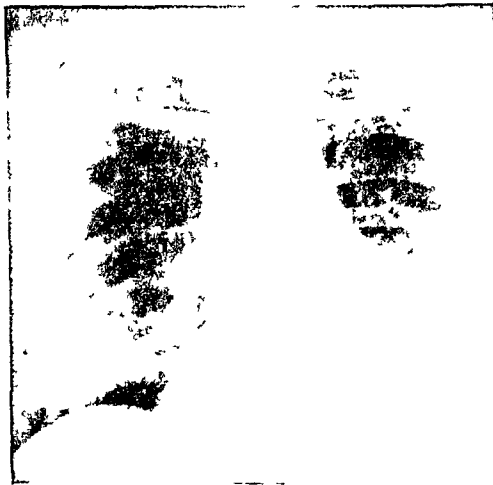


FIG 1. Roentgenogram of chest in upright position

Symptoms and signs peculiar to any type are not found, all of which make the correct recognition of any individual tumor more fascinating. This lack of significant signs or symptoms is perhaps most typically represented in the totally intrathoracic lipomas.

Many mediastinal lipomas offer a clue to the correct diagnosis by presenting themselves in part external to the bony thoracic cage. Fatty tumors which have their origin in the superior mediastinum may extend into the cervical areas, or may infiltrate through the intercostal spaces from the anterior mediastinum. Removal and examination of a portion of the presenting mass will verify the existence of a lipoma.

When completely intrathoracic, these tumors exhibit a confusing clinical picture.

A résumé of the available reports of adipose neoplasms occurring in this locale reveals a wide diversity of symptoms. Their clinical importance lies principally in their ability to produce effects by pressure. The tumor may cause dyspnea by compression of bronchi, which may cause compression or obstructive atelectasis, or by pressure on the heart and great vessels, cause interference with the intrathoracic circulation. Pain in the chest, cough, inspiratory wheezing, cyanosis and dysphagia may or may not be present. Aspiration of the pleural cavity was undertaken in several of the reported cases, because fluid was believed to be present, but none was found. Apparently neither sex nor age plays a rôle in the development of these tumors, for individual reports cite cases in both sexes and at various age periods.

The roentgenogram certainly is not decisive in making a diagnosis. The usual observation is that a soft tissue mass is superimposed upon the x-ray record of the lung field or the mediastinal structures; and if there is nothing found to identify the particular type of disturbance at hand, a sharp border, rounded edges, or a variety of various contours suggestive of other types of tumor may be found.

### CASE REPORT

As might be expected from the foregoing, the individual under consideration presented an interesting problem in diagnosis. In addition, he had two severe postoperative complications, and made a complete clinical recovery. Symptoms reported at the initial examinations pointed the way to the chest as the source of trouble. This soldier, aged forty-six, was

admitted with complaints of dyspnea and palpitation on exertion. Chest pain, cough, expectoration or ankle edema was not present.

roentgenogram of the chest revealed a large soft tissue mass which occupied the lower half of the left lung field and which displaced the

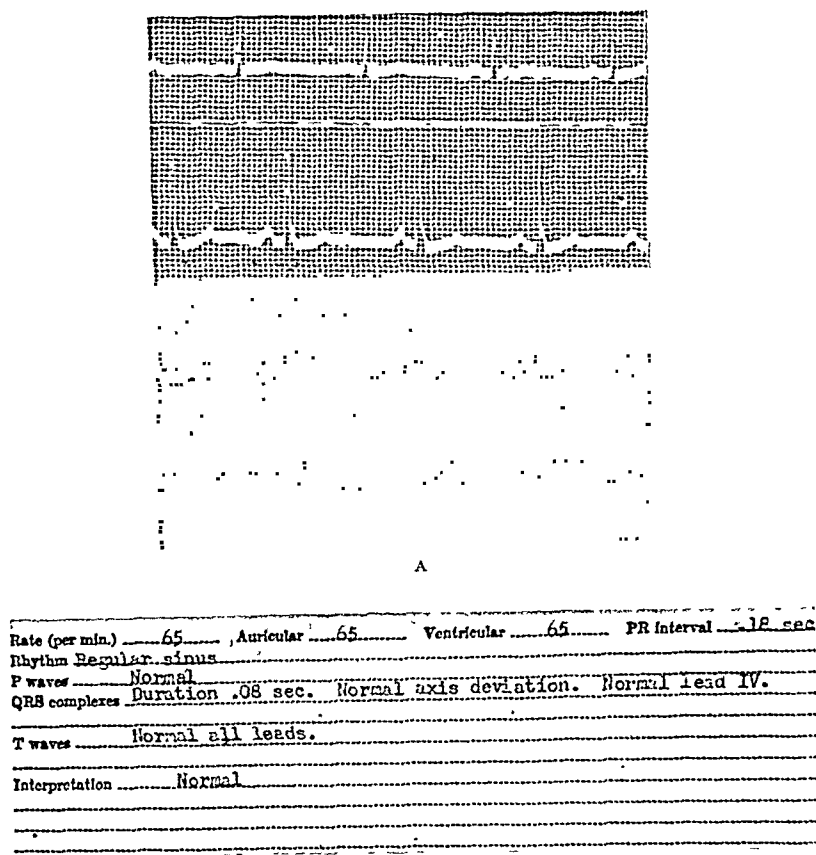


FIG. 2. A and B, preoperative electrocardiogram, December 12, 1942.

It is interesting to note that the patient had gained thirty-five pounds in weight in the two years previous to admission to the hospital.

Physical signs were limited to the chest. The initial examiners were under the impression that the patient was suffering either from pleural effusion or from pericardial effusion, as physical examination revealed flatness of the left base with absent fremitus, decreased breath sounds which angled off into the left axilla. The apex impulse over the pericardial area could not be seen or felt, or no thrill was present. The area of cardiac dullness at the level of the nipple extended 11 cm. to the left and 3 cm. to the right of the midsternal line. The cardiac rhythm was regular and no murmurs were heard. the blood pressure was 150/100 measured in millimeters of mercury.

The routine laboratory investigations were of no help in diagnosis. However, the original

heart and mediastinum to the right. (Fig. 1.) Under the fluoroscope the heart was found to be of normal size and the esophagus was pushed slightly toward the right. A small amount of either obstructive or compressive atelectasis of the lower portion of left lung was thought to be present. With the idea that the patient might have a diaphragmatic hernia, the gastrointestinal tract was studied after the administration of barium, but negative results were obtained. An electrocardiogram taken at this time showed no abnormality. (Fig. 2.)

Because of the peculiar roentgenographic picture, the left pleural cavity was aspirated, but no fluid was obtained. This negative result was later realized to have clinical significance, a fact which will be emphasized subsequently.

It was evident that the patient had a mass of obscure etiology in the left mediastinum which produced a slight degree of compression

of the left lower lobe, and indentation of the left lateral wall of the lower portion of the trachea, about  $1\frac{1}{2}$  cm. above the carina. This conclusion was reached as a result of the com-

that we were eventually persuaded to the conclusion that the existing pulmonary atelectasis was due to compression by the tumor mass. (Fig. 3.)

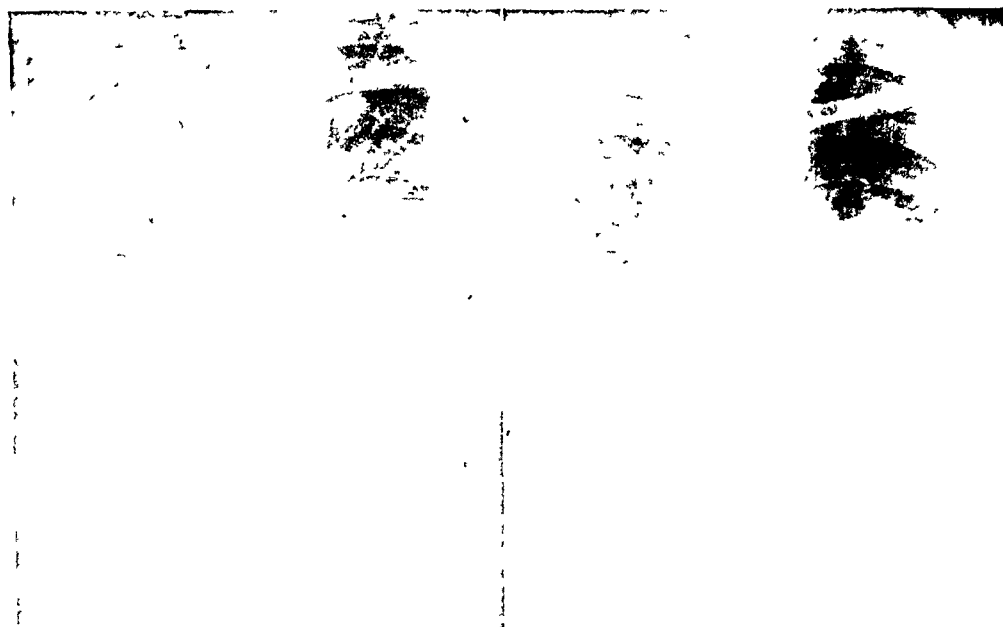


FIG. 3. Bronchogram demonstrating elevation and compression of left lower lobe

bined studies of the original roentgenograms of the chest, lipiodol filling of the left bronchial tree and information gained by bronchoscopy.

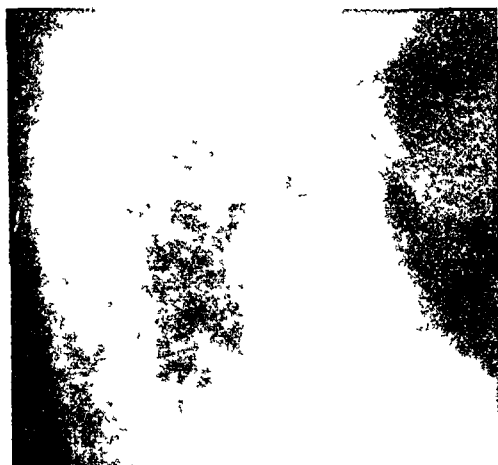


FIG. 5. Roentgenogram demonstrating anterior position of the mass.

FIG. 4. Roentgenogram with patient in exaggerated Trendelenburg position demonstrating flow of mass cephalad.

X-ray examinations of the thorax were made in the postero-anterior position, with the patient in an exaggerated Trendelenburg

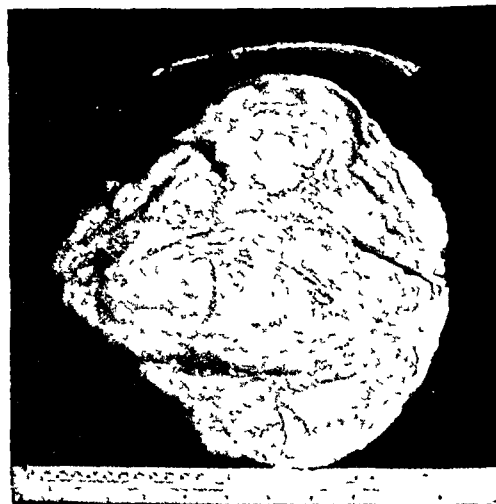


FIG. 6. Fatty tumor mass as enucleated at operation

There was no intrinsic alteration in the left lower lobe bronchi or in the tracheal wall. The effect was produced by external pressure, so

position. These films showed that this mass tended to flow cephalad. (Fig. 4.) Later, when the patient was again x-rayed in the normal

upright position, the intrathoracic mass flowed caudally.

pleural and extrapulmonary situation of the tumor mass.

At this stage of the diagnostic investigation,

Reconsideration of the various laboratory

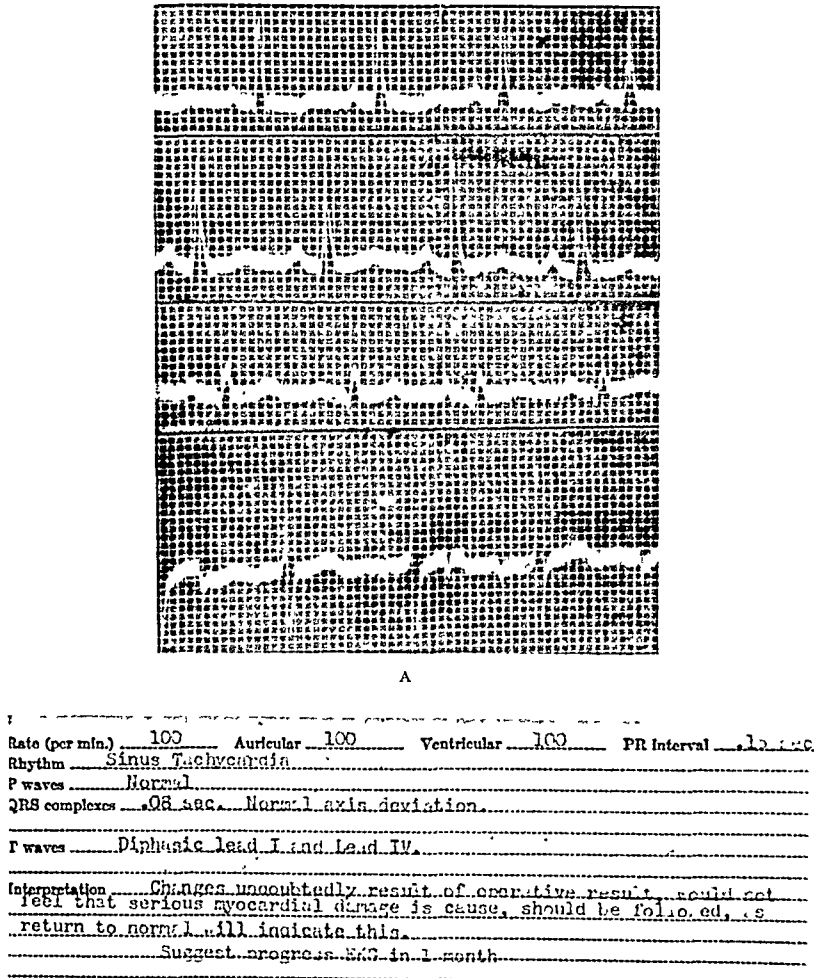


FIG. 7. A and B, electrocardiogram taken April 12, 1943.

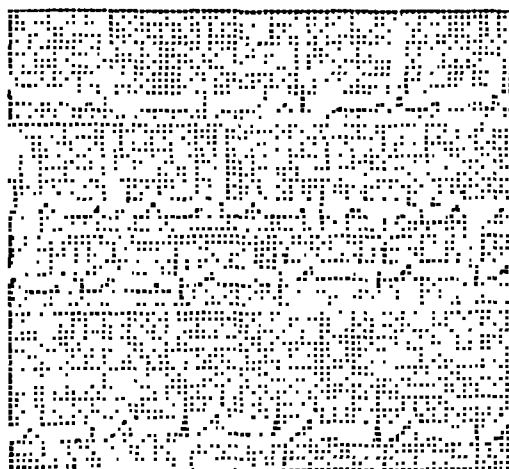
300 cc. of air was introduced into the left pleural space, and subsequently x-rays of the thorax were made which failed to show the presence of shifting fluid levels. These films were taken in various positions. The film taken with the patient lying upon his right side, and the x-ray projection made in the anterior posterior plane was the most revealing. This clearly outlined the costophrenic sinus on the left with a small cushion of air, showing in the contrast film adjacent lung tissue with the superposition of the smoothly curved border of the mass under study, both the lung and the mass itself having been separated from the parietal pleura by the intervening air. This demonstrated to us both the extra-

tests and diagnostic procedures which had been done revealed but one definite finding, that an extrapulmonary mass, which was extrapleural and quite large in size, was impinging upon the bronchus of the left lower lobe and compressing the lower portion of the left wall of the trachea. A moderate degree of atelectasis of the lower left lung had been produced by compression by the tumor mass. The very size of the tumor and the evident good health of the individual militated against a diagnosis of malignancy. Its anterior position in the chest (Fig. 5) tended to rule out the commoner types of tumor which are usually found in the posterior mediastinum. It was apparent that recourse



to surgery was in order. Removal of the tumor, if possible, was indicated, and incidentally would be the only method of arriving at an exact diagnosis.

The redundant borders of the capsule were then excised, and their substances sutured together. The lower and upper lobes of the left lung were expanded by exerting positive



A

Rate (per min.)	93	Auricular	93	Ventricular	93	PR Interval	.14
Rhythm	Sinus						
P waves	Normal						
QRS complexes	.08 sec. Prominent S wave lead III						
	Normal Lead IV						
T waves	Normal Lead I and IV. I voltage better and of good amplitude.						
Interpretation	Normal findings. No evidence of any residual change now.						

B

FIG. 8. A and B, electrocardiogram taken May 20, 1943.

Accordingly, operation was performed by one of us (T. B. W.). The patient was placed on his right side and an anterolateral incision approximately eight inches in length was made over the sixth rib. The rib was removed after stripping the periosteum from it. Thereafter, the rib above was cut through at the extremities of the operative exposure. The left pleura was then incised, and the chest contents explored. It was noted at this time that the lower lobe was compressed and elevated. The left upper lobe was only partially aerated, and it, too, was under a moderate degree of compression. The left lower hemothorax was filled with an encapsulated fatty tumor. This mass seemed to be about the size of a regulation football. This tumor was seen to lie between the left pleura and the pericardium, completely occupying the anterior mediastinum and having encroached upon the normal position of the left lung. (Fig. 6.) The tumor mass was delivered out of the chest cavity, its capsule incised, and the contents enucleated *en masse*.

intratracheal pressure, and the wound was tightly closed with chromic stitches. The skin surfaces were sutured with black silk. Following this, a bronchoscope was introduced and a small amount of mucoid material was aspirated from the bronchial passages.

Examination of the gross specimen showed it to be a mass of practically pure adipose tissue, weighing 1,500 Gm., and measuring 8 by 10 by 3 inches. Microscopic examination is reported by the hospital pathologist: "Adult Fat Tissue."

The immediate postoperative course was quite satisfactory, and the patient did well until the fourth day. When it became evident that fluid was present in the left pleural cavity, a roentgenogram showed that a moderate amount of fluid was present and that the heart and mediastinal structures were shifted moderately to the right; 700 cc. of sanguineous fluid was removed from the left pleural cavity, and although the patient was in no immediate danger, he was given a transfusion of citrated

blood. The patient obtained considerable benefit from both procedures.

Convalescence was then without event until the fifteenth day after operation when pain, swelling and tenderness over the superficial veins of the left upper arm were found. The area of thrombophlebitis extended from the cubital fossa to the tip of the shoulder, and the involved veins, the cephalic and its branches, were firm and tender. Moist heat, applied in the form of wet dressings, and elevation of the left upper extremity served to control the infectious process and it gradually receded with eventual complete resolution.

Relatively late in his convalescent period, a second electrocardiogram was made and the findings were entirely normal, with the exception that the  $r$  wave was diphasic in leads I and IV. (Fig. 7.) It was the opinion of the cardiac consultant that these changes were undoubtedly a result of the operation and that myocardial damage was not present. This opinion was substantiated by another electrocardiogram taken approximately one month later. The  $r$  voltage was better and the  $r$  waves were of good amplitude. The remainder of the tracing was normal and evidence of residual change was not found. (Fig. 8.)

With the exception of the accumulation of fluid in the chest, and the single episode of thrombophlebitis, the patient had a relatively uneventful course after operation. He regained strength rapidly, and during the latter stages of his hospital stay, was completely ambulatory. Mild exercise was undertaken without evidence of respiratory or cardiac embarrassment. At the time of discharge from the hospital, the patient had recovered his former health. Final x-ray examination demonstrated the complete absence of the previously present intrathoracic tumor, and a slight elevation of the left diaphragm due to the intrathoracic "pinching" of the left phrenic nerve at the time of the operative removal of the mass. (Fig. 8.)

From the standpoint of surgical treatment, this individual presented a problem to which reference has been made in other case reports. It has been recognized that hemorrhage is prone to occur relatively soon after operation, in spite of the fact that the tumor may have been easily enucleated from its capsule. Bleeding may

occur, although great care has been exercised by obtaining what seemed to be complete intrathoracic hemostasis, for it seems



FIG. 9. Roentgenogram taken at time of discharge from the hospital.

that these tumors have a peculiar propensity to bleed. This danger has been so real that some operators recommend thoroughly packing the area with gauze as a preventive measure to preclude hemorrhage. Whether this is done or not, the tendency of the tumor area to bleed should be kept in mind when the surgical treatment of lipomas is undertaken.

As far as diagnostic measures are concerned, some help may be obtained when the pleural cavity is aspirated under a mistaken impression that fluid may be present and none is obtained. The roentgen picture of intrathoracic lipomas often simulates that produced by fluid in the lower portion of the pleural cavity. Hence, if fluid is thought to be present and none is found after several punctures, it might be well to recall, among other things, that one of these unusual neoplasms may be present.

The introduction of air into the left pleural space was of considerable assistance in the determination of the extent, physical characteristics and situation of the mediastinal mass, by offering greater contrast in the x-ray studies made of the patient.

These studies led us to believe that we were dealing with a solid tumor mass

which was capable of undergoing changes in form, simulating those of a very viscid fluid. A mediastinal or intrathoracic mass which tends to "flow" slowly and which by needle puncture is proved not to be fluid should suggest the presence of a lipoma.

#### SUMMARY

The case history reported is that of a white male, aged forty-six, from whom a completely intrathoracic mediastinal

lipoma was removed. The difficulties attendant upon diagnosis of such a lesion are briefly reviewed and suggestions to aid in future recognition emphasized. Roentgenographic and electrocardiographic investigations of this individual are presented. In addition, some of the postoperative complications are reported. The soldier made an excellent recovery and is one of the few patients recorded in the literature who had a completely intrathoracic lipoma extirpated and survived this operative procedure.



POLYPOID changes and formation of polyps may occur with the edematous infiltration of the larynx of younger individuals. The polyp, although not often recognized as such, is in reality a neoplasm of tuberculous nature.

From "Tuberculosis of the Ear, Nose, and Throat" by Mervin C. Myerson (Charles C. Thomas).

# INSTRUMENTAL RUPTURE OF A FIVE MONTHS' PREGNANT UTERUS

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THE purpose of reporting this case is to point out several important observations which when analyzed retrospectively and a judicious interpretation given to signs and symptoms, the diagnosis might have been made earlier, the patient could have been better prepared for shock and the end results might have been less tragic.

Reading the literature one finds that rupture of the uterus is a rare obstetrical accident occurring at term or near term. It has occurred when midwives have not diagnosed the position of the fetus or have not observed the disproportion between the fetus and the pelvis. It has occurred in cases of prolonged labor in the presence of dystocia either fetal or maternal. It has been seen even when doctors have failed to appreciate the value of internal measurements. Ruptures have occurred with the indiscriminate use of oxytocics. It can be caused by external violence, such as is experienced in automobile accidents or falling down a flight of stairs. It is also caused by violent kicks or blows to the abdomen, such as the kick of an animal or a blow with the horn of an infuriated cow. Spontaneous ruptures have occurred in cases in which there was a previous cesarean section or in which a previous myomectomy was done. In these latter cases it seems that in the region of the scar of the previous section, the uterine wall will have a potential *locus minoris resistentiae* and as the uterus grows toward the latter part of pregnancy the uterus seems to be susceptible to a break through the scar tissue.

When rupture does occur, it is a serious obstetrical problem. Yet when it happens in the absence of sepsis, an early diagnosis

and an immediate surgical intervention has, at times, saved both the mother and child or the mother alone, if the infant was dead. But when the condition is permitted to go on for weeks, unrecognized, and in the presence of sepsis, as occurred in our case, the outcome is inevitably disastrous for both fetus and mother.

Briefly then, the causes can be enumerated as, bad procedures by midwives, unrecognized dystocia with prolonged labor, the indiscriminate use of oxytocics, external violence and previous cesarean sections or previous myomectomy.

Woodhull reports a case, an automobile accident, in which the rupture took place at seven months' gestation. Both fetus and placenta were extruded into the pelvic cavity through a rent in the posterior uterine wall followed by very little reaction. The patient was operated upon one month after the injury. The fetus was found macerated and the mother had an uneventful recovery.

De Lee reported a case in 1904 in which the patient fell down a flight of stairs. She was operated upon sixty hours after the accident, followed by a dead infant and uneventful recovery of the mother.

Stapleton from New Delhi, India, reported another case of rupture of ten days' duration from the time of accident, also with uneventful recovery of the mother.

I have mentioned these few cases because of their relationship in time from the hour of the accident to the time of the operation when compared with our present case. My patient gave no history of accidents or external violence. No history of a previous myomectomy or cesarean section. She was a nullipara. At the operation, the uterus showed no evidence of fibroma, fibro-





general pelvic inflammatory disease, pregnancy to be ruled out. The Aschheim-Zondek test (Friedman's) was ordered and two days later it came back doubtful. Another test was ordered. During the succeeding days the distention became worse. The patient vomited several times. Wangensteen suction was applied to reduce the distention and another transfusion was given. On July 5th, (eight days after admission and twenty-two days after the bloody vaginal flow) the patient's condition remained still poor; another transfusion was given and a laparotomy performed.

The abdomen was opened through a midline, lower incision removing the old scar. On reaching the peritoneum a dark bluish wave of fluid could be seen through the thinned out peritoneum and the suspicion of internal hemorrhage became evident. The peritoneum was opened under tension and a large quantity of liquid blood and organized large black clots were seen throughout the abdomen. The liquid blood was sucked out and the clots which extended as far as the border of the liver were scooped out with the hand.

In the right iliac fossa, a five (?) months' viable fetus in the intact amniotic sac could be seen anchored to the uterus with the cord protruding through a rent in the posterior uterine wall. On close inspection the rent could be seen extending longitudinally from the fundus to a point corresponding to the internal os. The upper part of the rent seemed to be somewhat organized; the lower part left an opening through which both cord and amniotic sac protruded. At this region the uterus felt boggy and mushy. Apparently nature had made an effort at repair, for the upper part of the rent was in a state of semi-organization, the lower part was matted by adhesions shared by a loop of the ilium and omentum. The uterus appeared to be enlarged to a five (?) months' pregnancy. In the light of these findings and in the presence of sepsis with the placenta still attached in the uterus a rapid supravaginal hysterectomy was deemed to be the operation of choice. At the region of the internal os, posteriorly, the uterus was very friable and necrotic. Thrombotic areas could be seen. At the completion of the hysterectomy, the pelvic floor was sprinkled with 5 Gm. of sulfanilamide and two cigarette drains were used. Shock supervened and the abdomen was closed with a through-and-

through suture. The patient expired forty minutes later. That afternoon the Friedman test came back positive.

*Comments.* The patient displayed considerable reluctance in giving information about herself. She convincingly denied any instrumentation to induce a miscarriage. Yet, in the face of the pathological findings, we know that she misinformed us. Spontaneous rupture in a young woman of twenty-seven and a nullipara would be well nigh impossible. There was no history of external violence and that would eliminate the possibility of a traumatic rupture. Even the menstrual history did not tally with the findings. Her last menstrual period took place in the beginning of April and on July 5th, when she was operated upon, would have made her approximately three months pregnant; and yet the fetus and the uterus corresponded to about five months' gestation. It seems logical and safe to assume that the instrumentation must have taken place at the time when she gave the history of vaginal bleeding for two days and that the instrument used tore the posterior uterine wall and entered the pelvic cavity. The accident must have taken place at about June 13th, approximately twenty-two days prior to the laparotomy. Did the fetus escape into the pelvic cavity at the time of the instrumentation or was it thrown out, subsequently, by the uterine contractions? It is conjecturable. However, the latter theory seems more probable. At what phase of her illness it did occur, cannot be precisely stated. The placenta was still attached and kept the fetus alive through the cord. According to the history given, the patient was never in shock. The acute initial stage had subsided. When she was admitted to the hospital, two weeks after the accident, she had entered a chronic phase, associated with pelvic infection and localized peritonitis. She exhibited evidence of intra-abdominal hemorrhage. The presence of marked pallor of the conjunctivae and of the gums with secondary anemia, asso-

ciated with low pressure (100/60) and a feeble pulse furnished all the earmarks of internal hemorrhage.

acute condition of the abdomen and with the suspicion of pregnancy, an x-ray of the abdomen would have solved the



FIG. 3.

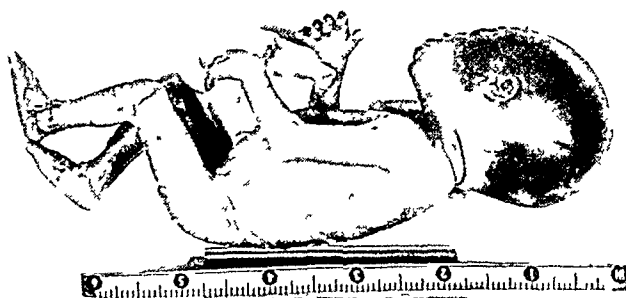


FIG. 4.

FIG. 3. Five months' fetus, anteroposterior view.

FIG. 4. Five months' fetus; lateral view.

She gave a history of vaginal bleeding for two days (two weeks before admission) and had not menstruated for three months. The persistent recurrence of intermittent lower abdominal pains in the presence of a large mass in the right pelvic fossa and a large uterus with the signs of internal hemorrhage, the possibility of tubular pregnancy stood out most prominently. Certainly, the latter diagnosis should have been the most plausible one.

The correlation of the above mentioned facts and a judicious evaluation of signs and symptoms made it imperative for an immediate exploratory laparotomy. However, notwithstanding all the misinformation received from the patient, this seemingly complex problem should have been solved much earlier. Entirely too much time was lost in waiting for the Aschheim-Zondek test. In the face of an

problem at once. The bones of the fetus are radiopaque after three months (Weitzner).<sup>\*</sup> In the presence of so much blood in the abdomen the x-ray would have shown fluid levels. The outcome of this patient might have been different with an earlier diagnosis and a better preparation to combat shock. Since the rent was complete and the pelvic cavity communicated with the external world, a potential focus of infection was introduced in the peritoneal cavity. The trauma to the uterine wall and the introduction of septic material, caused the endometritis, the myometritis and the parametritis with the subsequent local peritonitis. These pathological findings explain the cause for the temperature, the distention, the rigidity, the vomiting, the tenderness and rebound tenderness and the secondary anemia.

<sup>\*</sup> Radiologist, Morrisania City Hospital.



Once in the abdomen and confronted with a necrotic septic uterus with the placenta still attached, in spite of the poor operative risk, the operation of choice, in my opinion, should have been a rapid supravaginal hysterectomy. This was done. A hysterotomy was immediately discarded because at the lower segment of the uterine wall, in proximity to the rent, the uterus was necrotic. This uterine rupture must have been complete from the beginning. The nature of the instrument used will remain a mystery. The longitudinal rent extended throughout the entire thickness of the uterine wall including the peritoneum. At some phase of her illness the uterine contractions, manifested by the intermittent lower abdominal pains, must have expelled the fetus with its cord and amniotic sac into the pelvic cavity. The placenta remained attached and kept on nourishing the fetus through the cord.

The maternal death rate in all types of rupture ranges between 60 and 80 per cent and reaches 100 per cent for those patients not operated upon. The mortality is very high in those cases in which the rupture is complete, viz., where there is a communication from the vagina to the peritoneal cavity.

The first evidence of a ruptured pregnant uterus due to trauma is followed by either a vaginal bleeding or signs of intra-abdominal hemorrhage. However, cases have been reported in which there has been only a slight reaction or no reaction at all.

If the maternal mortality is to be reduced, it is of paramount importance that the diagnosis be made early and immediate surgical treatment be instituted. It cannot be overemphasized that first and foremost all efforts should be exerted toward the

control of shock, with intravenous glucose, plasma and blood transfusions. These last measures are so important that unless they are carried out, all efforts to save life by surgery will prove futile.

It has been said before, and it can be repeated here again, that unless the patient is well prepared to combat shock, the operation will be successful but the patient will die.

#### SUMMARY

1. This case must be classified as an instrumental rupture.
2. Too much time was lost in waiting for the Aschheim-Zondek test. An x-ray would have solved the problem immediately.
3. Success depends upon an early diagnosis and prompt surgical treatment.
4. All efforts should be directed toward the control of shock with glucose, plasma or blood transfusions.
5. During the operation the patient received a blood transfusion. She must have died of shock because with a slow, long standing, active, internal hemorrhage, she did not get enough blood.

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# ACUTE SPINAL EPIDURAL ABSCESS

## CASE REPORT

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**A**CUTE spinal epidural abscess is an uncommon disease which nevertheless presents an easily recognizable clinical picture if one is aware of it. The knowledge which we have of this disease seems to have been disseminated largely by way of surgical and neurological journals. Medical texts do not even mention the disease and surgical and neurological texts treat of it only sketchily. As late as 1941 Browder<sup>28</sup> says, "It would seem that the syndrome is still not generally recognized, as is indicated by the fact that 6 of the 7 recently encountered cases did not come under our observation until the disease was so advanced that application of appropriate therapy came too late to effect recovery." Since pain occurs at the onset, the chances of being seen by a doctor early in the course of the disease are great and it is important that the physician be aware of the possibility of acute spinal epidural abscess. The diagnosis must be made before the case can be referred for surgical treatment which seems to present the only hope of recovery, and hoping that a few more diagnoses may be made, if more persons were aware of the disease, this paper is presented.

**Incidence.** Acute spinal epidural abscess is not rare for 210 cases have been recorded,<sup>22</sup> but as late as 1941 it was referred to as a "little known disease."<sup>5,28</sup> Dandy,<sup>1</sup> in 1926, had not seen a case either during life or at necropsy. In thirty-three years at Charity Hospital, New Orleans, only four cases were diagnosed; at Kings County Hospital, Brooklyn, one case was diagnosed at autopsy, and at Mayo Clinic two cases are seen each year.<sup>19</sup> This case is the only one which

has been diagnosed from among 46,214 admissions to this hospital.

**Nomenclature.** Infection in the spinal epidural space has been variously designated as perimeningitis spinalis (Albers), pachymeningitis spinalis (Traube), peripachymeningitis spinalis externa (Nonne), epimeningitis spinalis, perimeningitis spinalis suppurative (non-tuberculosa), purulent perimeningitis (Campbell), and acute epidural abscess. Present usage seems to favor the term "acute epidural abscess."

**Etiology.** Acute epidural abscesses arise by direct extension from adjacent infections such as decubitus ulcers, perinephric and psoas abscesses, wounds of the back and diseases of the spine. The presence of such conditions usually suggests a causal relationship. The majority of the cases, however, present an antecedent history of skin infection in the nature of furuncles, boils and carbuncles and the epidural abscess is thought to arise from metastasis to the epidural space itself or to adjacent structures. This concept is supported by the bacteriological findings. Trauma, by establishing a locus minoris resistentiae, may favor localization of the abscess to a particular portion of the epidural space.

Some authors<sup>3</sup> wish to limit the concept of acute spinal epidural abscess to a metastatic infection arising directly in the epidural space but others<sup>22,27,28</sup> believe that metastatic infection is set up first in the vertebrae as a focus of osteomyelitis and then extends to the epidural space. Hunt<sup>27</sup> originally called attention to the similarity of the excruciating, boring pain in this disease to that seen in osteomyelitis of the vertebrae. Browder and Meyers,<sup>22,28</sup> return to this thesis and cite fourteen

cases of acute epidural abscess in twelve of which they have demonstrated osteomyelitis. This argument seems to constitute one of the minutiae of the pathology of the disease and in no way detracts from the opinion that most acute spinal epidural abscesses arise as metastatic infection from a distant focus.

*Bacteriology.* The staphylococcus is the usual cause of these abscesses and only occasionally have other organisms been found: pneumococcus,<sup>11,29,31</sup> streptococcus,<sup>12,28</sup> *Bacillus typhosus*,<sup>30</sup> and *Bacillus pyocyaneus* and actinomyces.<sup>18</sup>

*Anatomy.* The epidural space exists over the dorsal half of the spinal canal but anteriorly it is obliterated by the close relationship of the dura to the vertebral bodies.<sup>1</sup> The preponderance of dorsal collections of pus is thus explained anatomically, but anterior abscesses do occur.<sup>5,20,22</sup> All of the anterior abscesses have been associated with osteomyelitis of the vertebral bodies and most of them have finally caused a meningitis.

An epidural abscess may arise in any portion or may involve the entire dorsal epidural space but the majority localize in the thoracic region. There is no explanation for this fact.

*Clinical Features.* The case reports of acute infection of the epidural space present an almost constant clinical picture, the epitome of which is excruciating pain in the back accompanied by the signs of infection. The signs of infection are malaise, fever (100°F. to 105°F.), and leucocytosis (12,000 to 35,000).<sup>8,28</sup> The pain is distinguished by its severity and scarcely yields to very large doses of opiates, it may be localized in the back or may be radicular in character. Neurological manifestations appear after a variable latent period and if the disease is not treated they are progressive until the picture of transverse myelitis is fully developed at the level involved by the abscess. Death in the acute cases follows the onset of pain in as little as five to seven days; others (untreated) drag on for a period

usually not longer than six weeks and death results from the complications of urinary sepsis and decubitus ulcers.

Of the back pain Dandy<sup>1</sup> said, "The pain in spinal tumors or in fact in any other proved lesion, though seemingly of the same kind cannot approach in severity or persistence the pains of infection in the epidural space." The "root pains" may simulate pleurisy, gastric crisis, or peripheral neuritis.

Neurological manifestations appear as paresthesias or dysesthesias and motor weakness. Sensory and motor signs need not parallel each other for the anterior and posterior roots may be differentially involved by the inflammatory process. The time from onset of back pain to the appearance of neurological signs was five days in fourteen cases, six to nine days in nineteen cases, eleven to fifteen days in ten cases, and more than fifteen days in six cases;<sup>12</sup> periods as long as nineteen and twenty-seven days have been cited.<sup>28</sup> Incontinence is common.

The observation of stiff neck is frequent and although frank meningitis does not develop the finding of a pleocytosis in the cerebrospinal fluid is common. "There are no typical changes of the spinal fluid."<sup>20</sup> Increased protein is perhaps the most consistent departure from normal and frequently it is so much increased that the fluid coagulates. Intraspinous "block" can often be demonstrated by the Queckenstedt test but there is no differential value in this finding. "In spite of meningeal symptoms and signs the intellect is clear in practically every reported case."<sup>7</sup>

Tenderness of the spinous processes of the vertebrae overlying the abscess is almost a constant finding. Edema is occasionally found together with this tenderness and when present it is an added indication of underlying inflammation. X-rays of the spine usually fail to demonstrate osteomyelitis and they are of little value in establishing a diagnosis.

*Lumbar Puncture.* Most authors advise caution in the use of spinal puncture and

warn against the likelihood of passing the needle through an extradural collection of pus into the subarachnoid space and producing meningitis. Pincoffs<sup>16</sup> says, "... one may obtain at the same puncture on shift of the needle, first pus and then clear fluid or the reverse. . . . Such a result is pathognomonic of epidural abscess." We had this striking experience and it is recorded by others.<sup>6,7,19</sup> Weilbacher<sup>19</sup> aspirated in the lower dorsal region, the portion of the epidural space which is anatomically the narrowest and in which the procedure would be most hazardous. The depth of the epidural space varies inversely with the size of the cord.

The localization of back pain and the finding of tenderness and even occasionally edema over the spinous processes of the vertebrae in the involved region clearly indicate the site for doing the spinal puncture and if caution (i.e., "removal of the stylet with each advance of 0.5 cm.") be observed the likelihood of making the diagnosis directly is great. Militating against the obtaining of pus by every such aspiration is the fact frequently recorded<sup>5,11,15,18,19,22</sup> that the pus in the epidural space is in "numerous small pockets of pus" rather than in a single abscess.

Fear of contaminating the subarachnoid space seems justified. It was done inadvertently in our own case and meningitis did not develop. The best protection against infecting the subarachnoid space seems to be the foreknowledge of the finding to be expected and a suspicion of the correct diagnosis before undertaking the procedure.

*Treatment.* Treatment is laminectomy of all the vertebrae overlying the abscess and the institution of adequate drainage of the confined pus. Sulfonamides are of no value in the treatment of confined pus but it is interesting to speculate whether or not penicillin will be of value in such cases; both may prove to be valuable adjuncts to surgical treatment.

*Prognosis.* The fatality rate is 100 per cent in cases not drained surgically. The disease may run a fulminating course within five to seven days or drag on for several weeks,<sup>1</sup> death finally being due to decubitus, debility, and urinary sepsis.

When speaking of "recovery" we must think both of the individual and of restoration of function. Hope of recovery of nerve function is dependent upon prompt diagnosis and treatment; and if paralysis and loss of sphincter control has been present for several days, the chance of complete return of function is negligible. Echols<sup>5</sup> believes that, "If the diagnosis is delayed until paralysis has been complete for a number of days, operation is usually contra-indicated."

Rather numerous recoveries are recorded.<sup>5,8,12,15,16,17,19,24,25,26,28</sup> Madden and Bunch<sup>26</sup> state the operative mortality as 25 per cent, Gasul and Jaffe<sup>7</sup> gathered thirty-five operated cases and found a mortality rate of 51.3 per cent; from the literature as we have reviewed it there are eighty-four operated cases with a mortality of 33 per cent.

*Pathology.* The intervertebral foramina establish continuity between the epidural space and the extraspinal structures;<sup>3,4,7,13,20</sup> and when pus is found flowing through these intervertebral foramina, it is not easy to determine whether the disease began in extraneous structures and extended into the spinal canal or whether the reverse took place. It seems doubtful then whether it can be positively determined which epidural abscesses arise by "direct metastasis to the epidural space."

Similarly the discussion whether the epidural abscess arises from a metastatic focus of osteomyelitis in the vertebral body or whether the epidural abscess gives rise to a minimal osteomyelitis by reason of neighborhood relationships, seems difficult, if not impossible, of proof. Examination at the time of operation can scarcely be searching enough to substantiate either claim and from the few

necropsy protocols (our own among the number) it is not at all clear that the examiners have been aware of the possi-

operation and in this disease the oozing blood is little short of appalling. Pus is sometimes encountered in the muscles of

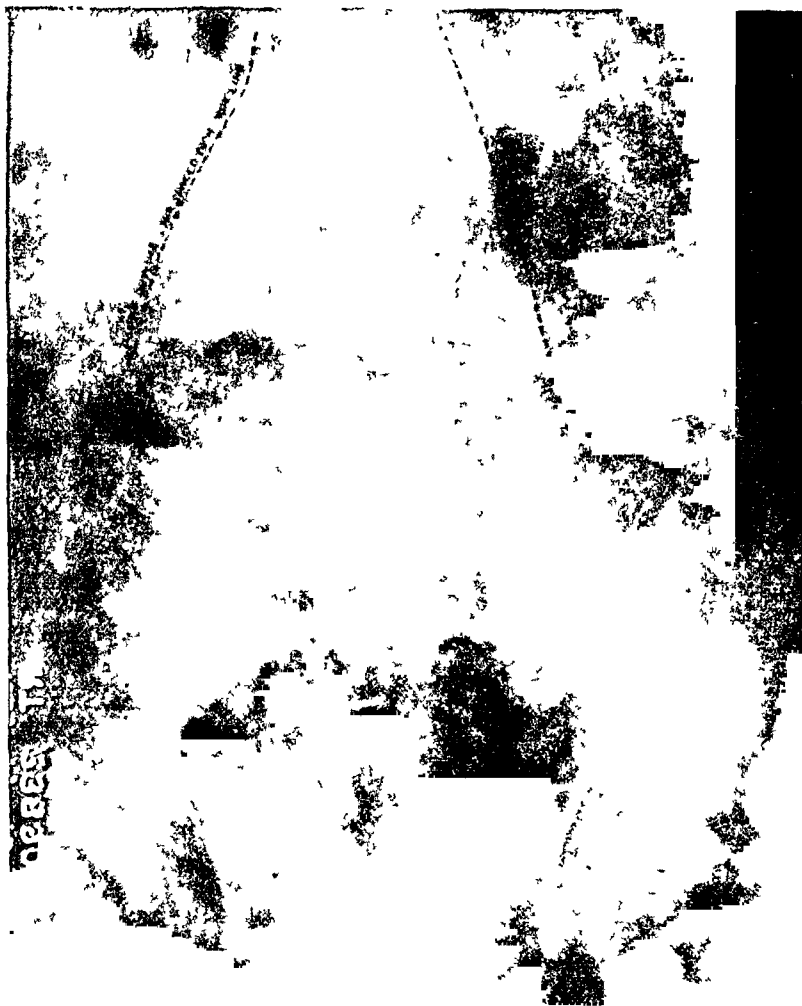


FIG. 1 Reproduction of the x-ray taken November 17th showing the distortion of the right psoas shadow. The film has been retouched by drawing a line 5 mm. outside of the true shadow.

bility or have looked carefully for osteomyelitis, especially if it be microscopic.

Extension of epidural infection through the intervertebral foramina accounts for the finding of inflammatory changes in the spinal musculature. This pathology is well described by Mixer and Smithwick,<sup>20</sup> "The operation is always a bloody one for the vessels of the spinal column and in the muscles of the back are markedly engorged as they are about any abscess cavity. A laminectomy is never a dry

the back from extension between the laminae or if not there may be much edema of the connective tissue between the muscles. When the laminae are removed, the epidural fat is hard and red and bleeds at the slightest touch. At the first attempt to strip the fat away from the dura, the abscess cavity is opened and thick pus under pressure wells out. Occasionally, the process shows some of the characteristics of epidural granuloma in that the epidural fat is hard and porky

and encloses multiple smaller abscesses. Such a process is much more circumscribed than the single frank abscess.” It is suggested that the single large

be said at present with respect to these pathologic changes in the spinal cord is that they are the result of circulatory alterations within the cord itself.”

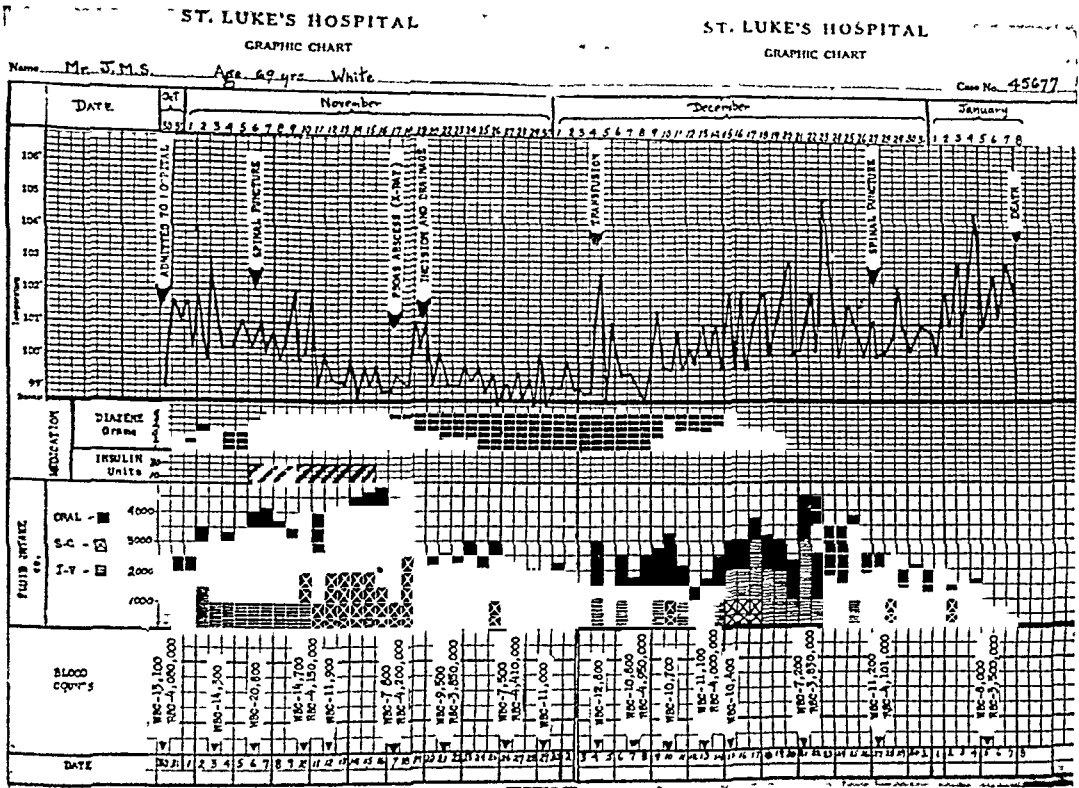


FIG. 2. This chart is self-explanatory. The essential features of the case are presented.

epidural abscess represents an earlier phase of the pathological process than the granulomatous thickening of the dura and epidural fat with pocketing of the pus. The microscopic pathology of these lesions is best presented by Browder and Meyers.<sup>28</sup> Myelomalacia or softening of the cord in the region of the epidural abscess has been observed but there is no certainty about the mechanism which produces it. Mechanical compression is postulated but compression is not often demonstrated.<sup>28</sup> Hassin<sup>9</sup> believes that the vascular supply to the cord is destroyed by thrombosis and by the local inflammatory changes. Certain it is that if paralysis is present for several days before drainage of the abscess, the neurological changes are for the most part permanent. Browder and Meyers<sup>28</sup> conclude, “The most that may

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Mr. J. M. S., No. 45677, age sixty-nine, white, had previously been well. In the past six months he had “numerous pimples and boils on the back of the neck.” A cholecystectomy had been done in 1935. For five or six days the patient had been suffering from a “cold” and had noticed urinary frequency but he had continued work as a railroad conductor. On October 29, 1943, there was sudden agonizing pain in the back while aboard his train. He was removed from the train and later returned to his home where he was unable to lie down because of his pain. Seen at his home by a local physician the diagnosis of “cold and sciatica” was made. In the morning of the following day the patient passed “bright red urine” that he thought was blood and

\* The chart of the hospital course calls attention to most of the salient features of the case.

because of this and his continued severe back pain he was admitted to the hospital.

His temperature was 100.6°F., pulse 120, respirations 24. The patient was in obvious distress, complaining bitterly with any movement of his back or legs. Coarse râles were heard at both lung bases. The abdomen was distended and an incisional hernia presented in the old cholecystectomy scar. No masses or enlarged viscera were felt and peristalsis was normal. The entire lower back was painful to palpation.

With the history of hematuria, acute back pain and costovertebral tenderness renal stone was considered. An x-ray of the abdomen (a kidney, urethra and bladder plate) was negative for calculi. The urine was found to be grossly bloody and to contain 4+ sugar.

On October 31st, a blood sugar of 238 mg. per cent and glycosuria led to the diagnosis of mild diabetes aggravated by infection. The patient was thought to be slightly disoriented.

Two days later a cystoscopic examination and a retrograde pyelogram of the right kidney was made. This pyelogram was normal in every way. It was the opinion of the urologist, (Dr. Frank M. Huff) that there was a benign hypertrophy of the prostate and a cystitis produced by a gram-negative coccus (not cultured).

On November 3rd the patient became irrational as testified by the patient's family. The complaint, by word and action, of pain in the back continued in spite of opiates. There was some radiation of pain down the right leg. On the following day (the seventh day since onset of back pain), pain extended into both legs but the right worse than the left. There was no paralysis and no incontinence. On November 5th irrationality continued and it was noted that the neck was resistive to anterior flexion; it was not rigid.

On November 6th, the neck was complained of by the patient and it was as before, resistive to flexion but not rigid. Slight pitting edema and tenderness were found in the right costovertebral angle. An effort was made to aspirate pus from the muscles of the right lumbar region with a No. 18 gauge spinal needle; none was obtained. Because of these findings and the tenderness of the spinous process of the third lumbar vertebra a lumbar puncture was done in the third lumbar interspace. Since pus was anticipated, the stylet was frequently with-

drawn and gentle suction applied. During this procedure the patient cried out with pain and exhibited much more reaction than usually seen during the procedure. At the approximate depth of the subarachnoid space 5 cc. of creamy yellow pus were obtained. Unwisely the needle was advanced a little farther and clear fluid was obtained. The admixture of pus and fluid precluded examination of the cerebrospinal fluid. It seemed obvious that an extradural collection of pus had been encountered and the needle carried across it into the subarachnoid space. The diagnosis of epidural abscess was made. The aspirated material showed gram-positive cocci. Sulfadiazine therapy was instituted at once.

On November 7th, the diagnosis of epidural abscess was not accepted by the surgical staff and further, the condition of the patient was considered too poor for operation. In view of the considerable back pain, osteomyelitis of the vertebrae was considered and x-rays of the lumbar spine were taken. They revealed no pathological process. A chest film taken at the same time showed patchy infiltration in the left lung field.

Pain in the back and legs and the confused mental state persisted.

Whether due to the use of sulfadiazine or not we are unable to say but meningitis failed to appear in spite of what we believe to have been gross contamination of the subarachnoid space. The neck became more supple rather than otherwise.

On November 9th, incontinence of feces was noted for the first time. It had been found that the patient was not eating the full diabetic diet prescribed but in spite of this 10 units of regular insulin were given from November 6th to November 15th and the urine became sugar free. On November 11th, the blood sugar was 138 mg. per cent; insulin was continued. The patient had fecal incontinence. Pain in both legs and back persisted.

Four days later the patient had a controlled bowel movement. Insulin was discontinued.

On November 17th x-ray of the lumbar spine revealed definite evidence of swelling in the region of the right psoas muscle, thought to be compatible with a psoas abscess. No osteomyelitis was seen. Two days later under local anesthesia the lumbar musculature was incised and pus readily obtained. About 4 ounces of creamy yellow pus welled into the wound.

Drains were inserted and no further investigation carried out.

Following this drainage the patient seemed to gain for a time, so much so that on December 1, 1943, he was able to sit in a wheel-chair for a half hour. The patient was mobilized in the hope that he might be stimulated to eat better and take an interest in recovering.

On December 2nd, the patient complained of violent pain in the legs, became nauseated, sweated profusely, and became disoriented. The red cell count had been sustained rather well throughout the illness but it was believed that a transfusion might bolster the patient; 500 cc. of blood were given but for some unaccountable reason this procedure marked a turn for the worse. (Crossmatching was rechecked and found to be in order.)

Prior to December 6th the patient had been able to ask for a urinal and had some control of his bladder but at this time he developed urinary incontinence (thirty-ninth day from onset of back pain). This persisted for the remainder of the patient's life.

On December 23rd the patient had a violent shaking chill. X-ray showed normal psoas shadows. Two days later lapses of consciousness were frequent and the patient was irrational and disoriented. On December 28th the patient's head began to tremble and the appearance of Parkinsonism was simulated. From this time forward the course was rapidly downhill and the patient expired at 11:15 A.M. on January 8, 1944.

Necropsy was done three hours postmortem. The body was that of an elderly male, obviously emaciated. Scars of previous operations were present in the right upper quadrant of the abdomen; over the sacrum there was a shallow ulceration but no decubitus. In the right lumbar region there was an incision 5 inches long, draining the abscess in the right iliopsoas muscle.

Examination of the viscera revealed little of significance. The lungs weighing 270 Gm. (left) and 340 Gm. (right) were atelectatic but nevertheless floated in water, no pneumonia was present. The heart weighed 240 Gm. and was flabby. The valves were normal and the arch of the aorta was singularly free of atheromatous degeneration. The gastrointestinal tract was normal except for multiple diverticula in the descending colon and rectosigmoid. The liver weighed 1,320 Gm. and

was smaller and firmer than normal. The gall-bladder had been operatively removed and its bed was occupied by a mass of omental adhesions. The pancreas was of normal size; the head appeared infiltrated with fat but there was no evidence of infection. The right kidney weighed 160 Gm. and the left 140 Gm.; the capsules stripped readily. On the surface of both kidneys were several yellowish spots, 1 to 2 mm. in diameter which were not necrotic but looked like tiny healed abscesses. The bladder and prostate were normal.

The brain was removed and the meninges were glistening and translucent; there was no thickening and no evidence of meningitis. The cerebrospinal fluid was clear. The falx cerebri was calcified. There were numerous small areas of liquefaction of brain substance over both hemispheres; most marked changes were seen in the right temporal lobe, just posterior to the Rolandic fissure.

The spine was examined from the ventral aspect. An incision made through the right iliopsoas muscle revealed pus welling out of the intervertebral foramen between the second and third lumbar. This pus did not communicate with the drainage incision in the back. There was extensive infiltration of the body of the right iliopsoas muscle by pus. The pedicles of the lumbar vertebrae were cut with a rongeur and the vertebral bodies removed. In so doing the dura was stripped away from the posterior aspects of the vertebra with what seemed to be considerable ease. Overlying the dura were numerous small pockets of pus. The dura was covered with coarse granulations and was much thickened, the filaments of the cauda equina were adherent to the dura anteriorly but they lay in clear cerebrospinal fluid. There was no apparent constriction of the dural sac but the inflammatory process involved the entire circumference of the spinal canal and extended from the upper border of the second lumbar vertebra to the lower border of the fourth lumbar vertebra. No osteomyelitis was seen. No other cause of death was found than the epidural abscess.

Microscopic examination of the left adrenal showed focal areas of infiltration by round and plasma cells in both the medulla and the cortex. The cortical cells showed slight vacuolization but otherwise there was nothing unusual.



Sections from the head of the pancreas showed a moderate increase in the amount of the inter- and intralobular adipose tissue with corresponding atrophy of the parenchymal tissues. There was no increase in fibrosis, however, and the islets of Langerhans appeared histologically normal. The atrophy of parenchymal tissue was not particularly striking and would be insufficient to give pancreatic insufficiency. Sections from the tail of the pancreas showed numerous islets (these are normally more numerous in the tail than in the head of the pancreas). In one region there was a circumscribed round area with a fibrous tissue wall lined by a single layer of cuboidal epithelium. This cyst-like structure contained numerous pink acellular round to ovoid bodies and had a central zone of concentrically laminated material with slight deposits of calcium.

The sinusoids in the central part of the lobule of the liver were dilated and distended with blood, and there was fairly marked atrophy of the liver cords in the same area. The liver cells showed fairly marked vacuolization characteristic of fatty changes; this again was more marked in the central part of the lobule. There was also a considerable amount of yellowish-brown granular pigment in the liver cells, most marked in the central portion of the lobule.

One surface of the dura was covered by a chronic inflammatory granulation tissue containing many plasma cells and showing in one area a small spicule of bone. On the other surface there was a portion of cauda equina surrounded by similar granulation tissue but less marked in the particular section.

There were focal areas of interstitial inflammation in the cortex of the kidney characterized by a collection of plasma cells, macrophages and polymorphonuclears, some of them eosinophilic. In a few areas there were early foci of necrosis. No Langerhans's giant cells or structures suggesting tubercles were seen. The tubules and glomeruli showed nothing remarkable.

*Microscopic diagnosis:* (1) Healing meningitis at level of cauda equina with epidural abscess; (2) chronic passive congestion and fatty changes of liver; (3) fatty infiltration with slight atrophy of parenchyma of head of pancreas; nodule in tail of pancreas; (4) healing focal inflammatory lesions of kidneys.

The meningitis, epidural abscess and inflammatory lesions of the kidneys were all healing inflammatory lesions of about the same duration apparently and presumably all due to staphylococci. The liver showed rather severe chronic passive congestion and moderate fatty changes. The changes in the pancreas were of incidental interest only. The fatty infiltration and slight atrophy of the head of the pancreas was not an unusual finding. The nodule in the tail of the pancreas was so degenerated that it was difficult to classify. It was apparently a cyst of some type, possibly parasitic, with marked degeneration and calcification of the contents. As is usually the case, the pancreas showed no anatomic lesions to explain the diabetes. It is possible that a mild diabetes was made temporarily worse by the severe infection and later improved.

#### COMMENT

A brief discussion of acute spinal epidural abscess is presented in the hope that it will bring to mind the clinical picture of this uncommon but nevertheless recognizable syndrome. The case described is typical of the disease and in addition presented a number of interesting features.

This case would appear to be one of the oldest cases reported, sixty-nine years, and the survival period without laminectomy seems to be one of the longest on record, seventy-two days. When it was not so clear what disease the patient suffered from, he was treated with a full course of sulfadiazine. We were unable to find any such previously treated case. Whether or not this treatment prolonged this man's life, we are unable to say. It would appear justified to use sulfonamide medication or penicillin as an adjunct to surgical treatment.

The mild diabetes which appeared in this case is hard to explain. There is no reason for supposing that it was a "starvation glycosuria" for the patient's diet was adequate throughout. That it was aggravation by infection of a latent diabetic tendency seems a poor explanation for infection continued, but the diabetes disappeared. It can only be conjectured whether or not the pancreas was involved

by metastatic infection at the outset, when a septicemia must have existed which gave rise to the epidural abscess and the bilateral miliary kidney abscesses.

It was of interest that a psoas abscess was visualized by x-ray nineteen days after the onset of pain, that this abscess was drained and that at necropsy there appeared to be no direct communication between this abscess and the pus exuding from the intervertebral foramen between the second and third lumbar. This failure of communication may have been an artefact but it can also awaken the suspicion of a metastatic infection arising simultaneously in both the psoas muscle and in the epidural space.

The sequence of events with respect to neurological signs could not be followed as desired because the patient's mental condition made sensory examination meaningless. However, six days after onset of backache pains extended down the right leg; seven days after onset pain radiated down both legs; on the twelfth day fecal incontinence and on the thirty-ninth day urinary incontinence appeared. Complete paralysis of the legs was not present. Decubitus ulcers did not develop and as demonstrated at autopsy, urinary sepsis was not significant. Death seemed to be due to chronic debility secondary to the epidural abscess in the region of the cauda equina.

The case was first diagnosed by means of lumbar puncture and the findings were so conclusive in the light of the literature that laminectomy should have been done at once. It seems worthy of comment that a resistant neck was present before lumbar puncture was done, that the needle was passed through the abscess into the subarachnoid space and yet meningitis was not aggravated. The sulfadiazine therapy may have had a salutary effect.

Necropsy revealed a granulomatous inflammatory lesion which involved the epidural space throughout its circumference from the level of the second to that of the fourth lumbar vertebra. Thus

this abscess involved the anterior epidural space and in common with other abscess located anteriorly, meningitis was present. Osteomyelitis may also have been present and as a suggestion of this was the finding of a "spicule of bone" in the inflammatory mass surrounding the dura.

#### CONCLUSION

A case of acute spinal epidural abscess is presented with autopsy findings. The treatment is surgical but diagnosis is the province of anyone capable of making it. We believe that more diagnoses will be made if more practitioners become aware of epidural abscess as a cause of "excruciating pain in the back, sudden in onset, and accompanied by the evidence of infection."

We wish to acknowledge our indebtedness to R. L. Edmonson, roentgenologist, for the reproduction of the x-ray film.

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# ADENOCARCINOMA OF THE ILEUM IN A GIRL OF THIRTEEN\*

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A REVIEW of the literature reveals a comparative dearth of recorded cases of carcinoma of the small intestine in the young. Duncan,<sup>1</sup> in 1886, reported an instance of carcinoma in a male child of three and one-half years. Necropsy revealed that the tumor had involved a portion of the small intestine as well as the liver and both kidneys. The primary origin of the tumor was not stated. Another carcinoma of a youth of twenty years of age, was presented by Macewen<sup>2</sup> in 1922. In this case the onset was very sudden with violent pain, persistent vomiting, and great abdominal distention. The patient was admitted to the hospital *in extremis*. At laparotomy, a tumor the size of a small walnut projected from the side of the upper ileum and a small perforation was found at the base of the tumor. The abdominal cavity contained copious free fluid and liquid fecal matter. Apparently the tumor had caused ulceration of the bowel wall and had then protruded through the aperture. In this case a second pedunculated tumor was found, about two inches lower down, in the bowel. The abdomen was rapidly cleaned out and enterostomy was performed, but the patient died a few hours later.

The following is a report of another primary carcinoma of the small bowel occurring in childhood:

## CASE REPORT

The patient, a school girl aged thirteen years, was admitted to University Hospital on December 26, 1942. One year before admission she first sustained an attack of severe pain about the umbilicus and in the right

lower quadrant. It was shortly followed by nausea and vomiting. On the following day she was comparatively well, but in about two months the abdominal pain of colicky character together with the nausea and vomiting recurred and continued intermittently for a longer period of time. She remained symptomless between attacks. The attacks increased in frequency and severity during the six weeks before admission. The patient was weak and lost about fifteen pounds. The present attack of intermittent pain began on December 23, 1942, and lasted three days which was longer than the other attacks. This was accompanied by nausea and vomiting of greenish-yellow matter. No hematemesis or melena had been noted. No change in bowel habits had occurred. The past and familial histories were essentially negative.

The temperature was 100°F., with the pulse rate 102 and respirations 22. She was well developed but undernourished and pale. She appeared lethargic and acutely ill. Her abdomen moved freely on respiration and showed neither distention nor peristalsis. During an attack of pain a sausage-shaped mass was palpable in the right lower quadrant. Increased peristalsis was heard in this area. The mass was freely moveable, somewhat tender and guarded by resistant muscles. It migrated and was later felt just above the umbilicus.

The red blood count was 4,940,000 with the hemoglobin, 14 Gm. per 100 cc. The white blood count was 12,500 with the neutrophils 83 per cent, lymphocytes 15 per cent, monocytes 1 per cent and eosinophiles 1 per cent. Urinalysis was negative. Blood chloride determination was 495.0 mg. per 100 cc. The carbon dioxide combining power was 33 volumes per cent.

It was concluded that the patient had a mechanical obstruction of the small intestine originating in intussusception. The intermittent attacks of abdominal cramps continued

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during the day of admission in spite of a Miller-Abbott tube which had been inserted to a low segment of the small gut with adequate

She was again seen in University Hospital for follow-up study in January, 1944. During these twelve months the patient enjoyed



FIG. 1. A, polypoid form of carcinoma of ileum. Note the small benign polyp at its side.

suction attached. Exploratory laparotomy done by one of us (I.D.P.) on December 27, 1942, revealed an easily reducible ileal intussusception about four feet proximal to the ileocecal valve. Upon reduction of the intussusception, a small tumor was discovered involving the inside of the ileum. The serosa of the ileum outside the tumor appeared thickened and white. Further exploration showed the mesenteric lymph nodes to be generally enlarged but not indurated. They were soft and fleshy in appearance. There was no other evident gross pathological condition. The balloon of the Miller-Abbott tube was, therefore, deflated and the tube was extracted to about five feet proximal to the region of the tumor. The tumor as well as about three inches of normal ileum on either end of the tumor was resected. The ends of the ileum were closed by an inner row of No. 00 intestinal chromic catgut and an outer row of No. 00 intestinal black silk. Side-to-side isoperistaltic anastomosis of the ileum was then accomplished using an inner row of No. 00 chromic catgut and an outer row of No. 00 black silk. The opening in the mesentery was closed by interrupted sutures of fine black silk. One of the large lymph nodes of the mesentery was excised for biopsy. Five Gm. of sulfathiazole were applied into the peritoneal cavity about the region of anastomosis.

Convalescence was uneventful. The Miller-Abbott tube was removed on January 2, 1943. She was sent home January 11, 1943.



FIG. 1. B, lateral view; polypoid form of carcinoma of ileum.

entirely good health. There were no gastrointestinal symptoms. She gradually gained weight from eighty pounds at the time of operation to 103 pounds at the time of this examination. Pallor had disappeared. The red blood count was 4,850,000 with the hemoglobin 13.0 Gm. per 100 cc. The white blood count was 6,750 with the neutrophils 56 per cent, lymphocytes 39 per cent and monocytes 5 per cent. Stool examinations for blood were negative. A complete gastrointestinal x-ray series was negative. The sedimentation rate was 8 mm. in one hour, which is normal. The basal metabolism rate was minus 1 per cent which is normal.

The gross appearance of the specimen (Fig. 1A and B) was that of a small, fungating, cauli-

flower-like mass which projected into the lumen of the small intestine for about  $1\frac{1}{2}$  cm. Its surface measured 2 by 3 cm. It showed only little tendency to invade the deeper tissues. An apparently benign polyp was at its side.

Microscopically, the tumor was an adenocarcinoma grade II malignancy. (Fig. 2.) It was composed of fairly well formed glandular tubules which penetrated into the muscularis. The tubules were often only lined by a single layer of epithelial cells and some sections suggested the appearance of an innocent adenoma. Thus the tumor may have arisen as a malignant transformation of a papillary adenoma. The mesenteric lymph node revealed the presence of a catarrhal lymphadenitis with no evidence of metastatic carcinoma.

#### COMMENT

The outstanding feature of the case is the age of the patient. In fifty-five cases of carcinoma of the small intestine collected from the Mayo Clinic by Rankin and Mayo<sup>3</sup> in 1929, the average age incidence was 47.5 years and ranged from thirty-two to sixty-nine years.

There was no evidence of metastasis. The surgical treatment was presumably instituted early principally because the associated intussusception produced such severe pain and typical symptoms of mechanical obstruction that exploration became necessary.

We wish to express our appreciation to Dr. George M. Curtis and Dr. Harry L. Reinhart for their help.



FIG. 2. Adenocarcinoma of the ileum showing glandular formation in muscularis.

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# INCARCERATED HERNIA IN INFANCY\*

## CASE REPORT

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THIS case is being reported for the following two reasons: (1) the age of the patient, and (2) the unusual complication associated with the incarcerated hernia.

## CASE REPORT

J. P. N. entered St. Francis Hospital at 11:15 A.M. on May 10, 1943, with the following history: He had been delivered normally at term in February, 1943, and developed normally. His weight at birth was 5 pounds and 12 ounces. The child had been well until March 13, 1943, when loose stools containing some blood were noted. He recovered slowly from this and was well until noon May 9, 1943, when it was noted he had a fever of 100°F. At the same time a swelling was noted in the right scrotum.

Examination at the time of admission revealed a dehydrated child, drowsy and listless. His temperature was 99.6°F. and his weight was 7 pounds 4 ounces. The abdomen was distended and tender to touch in the right lower quadrant. The scrotum was red and there was a mass about 4 by 4 by 8 cm. in the right scrotum extending into the right inguinal canal. At the time of admission the baby vomited a moderate amount of bile stained material. The right testicle was not felt and the mass did not transmit light. The fontanels were depressed. Examination of the heart and lungs was negative. A diagnosis of an incarcerated right inguinal hernia was made and he was brought to the operating room about two hours after entering.

Under vinethene and ether anesthesia, a right inguinal incision about  $2\frac{1}{2}$  inches long was made  $\frac{1}{2}$  inch above and parallel to Poupart's ligament. The external oblique fascia was divided, the inguinal canal opened and the mass delivered. The sac was opened and contained a moderate amount of sero-

sanguineous fluid. On delivery of the sac contents these were discovered to be the head of the cecum, the proximal ileum and the appendix, which was lying free in the sac. A perforation was noted in the appendix at about its midpoint. The appendix was removed by tying with catgut and cutting the meso-appendix, tying the base of the appendix with catgut and removing with the cautery. The stump was not inverted but was replaced in the abdomen and 2 Gm. of sulfanilamide powder were sprinkled over the stump, into the abdomen and into the wound.

The hernial sac was divided at the internal ring, the proximal segment closed with catgut and in order to save time the distal portion was left. The conjoined tendon was brought to Poupart's ligament with catgut and the external oblique fascia was closed with catgut. The cord was not transplanted. Interrupted silk was used in the skin. The whole procedure took about forty-five minutes.

The report of the pathologist was as follows: Macroscopic: The specimen is an appendix 3.5 by 0.4 cm. The serosa is 3 plus injected. A segment, 3 mm. long, in the center appears necrotic in all coats and there is a small perforation. The wall is soft, mucosa hyperemic in the remainder of the appendix. The lumen contains mucoid fluid. Microscopic: Sections represent an acute, suppurative and necrotizing appendicitis. Diagnosis: Acute appendicitis with perforation.

Post-operatively the child had a stormy course. His temperature rose to 106°F. that evening, his respirations were 48 and his pulse 140. An infusion of 200 cc. whole blood and 100 cc. of saline was given by special needle into the marrow of the right tibia,  $\frac{1}{4}$  gr. sodium luminal was given for restlessness and external heat was applied to the abdomen.

The next day he was given tea by mouth and a soapsuds enema. Sulfadiazine,  $\frac{1}{4}$  gr. was given every four hours and glucose and

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saline were given into the right tibia. The second day he was put on a formula of equal parts of skimmed milk and tea, 4 ounces at each feeding every four hours. The formula was changed the next day to skimmed milk, 7 ounces, whole milk, 5 ounces, water 12 ounces and divided equally for six feedings.

On May 14, 1943, the formula was changed to whole milk 12 ounces, water 12 ounces. On May 15, 1943, the temperature was normal, the sulfadiazine was discontinued and the formula was whole milk 14 ounces, water 10 ounces. Dextro-maltose 1 ounce, Drisdol and cevatic acid were added.

On the eighth day, May 18, 1943, the skin sutures were removed and there was a moderate amount of serous drainage from the wound. This persisted until May 25, 1943, the fifteenth postoperative day. He was dismissed from the hospital May 30, 1943, twenty days after entering and weighed 8 pounds and 1 ounce.

At examination on March 15, 1944, the scar was firm and well healed, there was no evidence of a recurrence of the hernia and the child was apparently healthy and weighed 13 pounds, 8 ounces.

An incarcerated inguinal hernia in infancy is not uncommon. Thorndike and Ferguson,<sup>1</sup> reporting on 906 patients with a diagnosis of incarcerated or strangulated inguinal hernia during a ten-year period in a series of 1,740 operations for inguinal hernia in patients under twelve years, stated that the greatest incidence of incarceration occurred during the first six months of life, and after the age of eighteen months there was a steady fall in the incidence of incarceration up to the age of six. The predominance of males as well as the predominance of the right side is verified in the present case. They found that 80.2 per cent involved the right side. There is an excellent discussion of the differential diagnosis of incarcerated hernia in infancy and childhood in this paper and anyone interested should consult this article as the author of the present article does not believe that he can add anything new.

According to Wakeley,<sup>2</sup> hernia of the appendix is a well known clinical entity

and amounts to over 1 per cent of all hernias. He reports sixteen cases of herniated appendices in 2,000 cases of hernias of all ages. However, only one case was in the age group of one year, and in this patient, the appendix was not ruptured. The average age of the sixteen patients was approximately forty-five years.

Remsen<sup>3</sup> reported a case which closely simulated the one in the present report in many ways. However, the appendix was not perforated and there was an associated hydrocele. This patient was sixteen days old. The whole appendix was not in the hernial sac.

Golden and Hamilton<sup>4</sup> reported a very interesting case of a strangulated hernia in an infant of five weeks. In the sac was found an acutely inflamed appendix. The appendix was not ruptured but associated with the acute appendicitis was an acute testicular inflammation.

Holzel<sup>5</sup> reported the postmortem findings in a thirty-two days old infant which showed a ruptured appendix in a hernial sac. However, there was no sign of an incarceration although clinically from the history there very likely was a loop of bowel in the right inguinal region.

If one considers the anatomy and embryology of this condition, he is at a loss to explain its occurrence. Surgeons who have had a great deal of experience agree that the appendix in an infant usually lies high in the abdomen. Because of this in acute appendicitis, I usually make my incision, which is the Battle or the right rectus-muscle inward retracting incision, higher than normal in infants or children. There is no doubt about the congenital origin of the hernia, but it is difficult to explain the presence of the appendix in the hernial sac at the age of three months.

#### CONCLUSIONS

1. Incarcerated hernia is not uncommon in infancy or childhood.
2. Appendicitis or ruptured appendicitis is also not uncommon in infancy or childhood.



3. Incarcerated hernia containing a ruptured appendix is exceedingly uncommon in childhood and infancy.

4. A case of an incarcerated hernia containing a ruptured appendix in a child three months old is reported with a favorable result. I was unable to find a similar case in the literature.

I wish to thank Dr. Ellen P. O'Flaherty of the Department of Pediatrics of St. Francis Hospital for her help in the preparation of this paper and for her capable handling of the postoperative feeding problem this patient presented.

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WHILE carcinoma of the duodenum is exceptional, carcinoma of the stomach is one of the captains of the men of death. Four thousand persons die annually from this disease in Britain, and nine thousand in America (Sherren). Males are twice as often affected as females.

From "A Short Practice of Surgery" by Hamilton Bailey and R. J. McNeill Love (H. K. Lewis & Co. Ltd.).

# CARCINOMA OF THE SMALL INTESTINE

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TO date, less than three hundred cases of carcinoma of the small bowel have been reported. For statistical reasons, it seems justifiable to report even a single additional case. The rarity of the lesion is evidenced by the fact that in certain standard textbooks of surgery and pathology, no mention is made of it at all. Yet when one is faced with it at the operating table, it ceases to become a pathological curiosity and becomes of tremendous practical importance to both surgeon and patient. Every general surgeon should familiarize himself with these tumors, for very few consider this condition in the differential diagnosis of vague abdominal disorders.

As with malignant tumors in general, the greatest chance of obtaining a cure lies in early diagnosis. The importance of thoroughly investigating even vague gastrointestinal complaints cannot be over-emphasized. The technic of gastrointestinal surgery has more nearly reached perfection than our diagnosis of gastrointestinal cancer has; and until we discover the cause of cancer, our hope rests more in earlier diagnoses than in further perfection of surgical technic.

*Pathology.* Carcinomas of the small intestine occur most frequently in the jejunum. Mayo and Nettrour report thirty-one jejunal carcinomas, twenty-one duodenal carcinomas, and eighteen ileac carcinomas. Medinger reports twelve jejunal carcinomas, three duodenal carcinomas and seven carcinomas of the ileum. Judd similarly found eleven carcinomas of the jejunum, five in the duodenum and five in the ileum. Maingot's personal series included three jejunal carcinomas and one carcinoma of the ileum.

These neoplastic growths may be annu-

lar, sessile or pedunculated, and are usually adenocarcinomatous in character. The most common form is a constricting adenocarcinoma, which causes localizing symptoms by producing intestinal obstruction. The sessile and pedunculated variety may cause intussusception, and all varieties are very prone to bleed freely into the intestinal lumen.

Metastasis occurs early and eagerly in most instances, or perhaps it would be more correct to assume that localizing and alarming symptoms occur after the tumor has been present for a considerable time only and has had the opportunity to metastasize liberally. A state of intestinal obstruction, or signs of malignancy necessitating operation is usually a late manifestation of the disease. Metastasis occurs first to the mesenteric lymph nodes and peritoneum and thence to the lungs, liver and long bones.

*Symptoms and Signs.* Symptoms and signs from carcinoma of the small intestine are dependent upon defective gastrointestinal absorption, defective motility of the bowel, bleeding of the tumor and finally the production of intestinal obstruction.

Cramps, epigastric distress and dyspepsia, gurgling of gas in the bowels, bloating, and loss of weight are the common symptoms. Vomiting is a variable symptom and constipation is even more variable. Of the objective signs, anemia and occult blood in the stool are the most constant findings. Shifting abdominal tenderness, bloating and the presence of borborygmi on auscultation may be present during an attack of intestinal obstruction resulting from the tumor.

*Diagnosis.* The importance of x-ray examinations in tumors of the stomach and colon lends itself to no argument.

In the small intestine, the observation of barium is rather difficult to interpret, and in the presence of intestinal obstruction may constitute a real hazard. The lesion is occasionally revealed as a narrowing of the intestinal lumen, and retention of barium in the small intestine for more than eight hours should be looked upon with suspicion. A positive roentgenological diagnosis is perhaps made in less than one-third of the cases. However, it is very useful in ruling out pathological conditions of the stomach, duodenum and colon when symptoms and signs point to a gastrointestinal lesion.

A test for occult blood should be made in every case of suspected gastrointestinal disease. Obviously, routine hemoglobin and red cell studies are indicated. When these tests indicate bleeding into the gastrointestinal tract, and roentgenological examinations rule out the stomach, duodenum and colon as sites of bleeding, it can be assumed that the occult blood is coming from an ulcerative lesion of the small intestine. The majority of cases of carcinoma of the small bowel that are seen have a history of intermittent attacks of intestinal obstruction; and when this history is combined with the above findings, diagnosis is reasonably certain.

As pointed out by Mayo and Nettrour, other diseases are often present in persons of the age group in which cancer of the small bowel occurs, and this often confuses and distorts the picture. This fact emphasizes the importance of careful and complete diagnostic methods, and of careful and methodical abdominal explorations at the operating table. Several pathological conditions are often present in the same abdomen. The case to be reported also had a duodenal ulcer, which could easily have caused the dyspepsia and pain, anemia and occult blood in the stools, all of which are important symptoms and signs of small intestinal malignancies.

*Surgical Treatment.* Resection and end-to-end anastomosis of the small bowel (the resection including 8 or 10 inches

of normal bowel on each side of the tumor and a long wedge of mesentery) is, in general, the procedure of choice. In carcinoma of the terminal ileum, the procedure of choice is removal of the lesion with a good margin of proximal ileum and either the cecum and part of the ascending colon or a hemicolectomy as practiced for carcinoma of the cecum. Even in most cases of obvious metastasis, resection is indicated, as it rids the patient of an ulcerating, bleeding and obstructing growth which hinders nutrition and general health more than the metastasis would. Occasionally enlarged lymph nodes in the mesentery are found to be purely inflammatory rather than neoplastic.

It must be pointed out that resection of carcinoma of the small intestine is followed by a mortality rate as high as 40 per cent.

*Prognosis.* The prognosis for patients with carcinoma of the small intestine is poor. Approximately 5 per cent obtain the so-called "five-year cure," because of the early metastasis (or the late appearance of symptoms severe enough to demand attention). However, as indicated before, the improvement in general health, and the relief afforded to the patient by irradiation of the obstructing, bleeding lesion in the intestine certainly justifies the operative procedure in most cases.

#### CASE REPORT

The patient, a forty-three year old white female, was admitted to the hospital on November 18, 1943, complaining of recurrent attacks of lower abdominal pain of about five weeks' duration. During the past two weeks there had been occasional cramping pains with bloating, rumbling of gas in the bowels and two attacks of vomiting. Bowel movements had been regular. She had had irregular menstrual flow for the past eight months and had not menstruated for the past two months. She had had some frequency of urination and nocturia. There had been no loss of weight.

Examination revealed a well developed and nourished woman who was not acutely ill. The abdomen was slightly distended and there

was marked tenderness in the left lower quadrant. Peristalsis, on auscultation, seemed normal. Pelvic examination revealed a normal uterus and right adnexa, but in the left adnexal area tenderness was so marked that examination was unsatisfactory. Rectal examination was negative.

Laboratory studies revealed an anemia (red blood cells 3.9 million, hemoglobin 9.5 Gm.). Sedimentation rate was 49 mm. in one hour, and the white blood cell count was 10,150. Temperature varied between 99 and 100°F.

She had previously had a roentgenological study of the upper gastrointestinal tract which was reported as negative. A barium enema did not reveal any lesion of the colon. A presumptive diagnosis of partial intestinal obstruction due to a left tubo-ovarian inflammatory process was made.

Treatment consisted of a liquid diet, hot packs to the abdomen, hot vaginal douches and small enemas. Improvement in her condition was noted, but a repeated blood count several days later showed a progression in the anemia. To rule out ectopic pregnancy, a Friedman test was done and was negative. She was given three 500 cc. blood transfusions. Improvement was satisfactory and she was discharged on December 4th with no symptoms.

On December 31st she returned to the hospital, stating that she had felt perfectly well until that morning, at which time she was seized with cramping epigastric pain and vomited several times. Examination revealed moderate distention of the lower abdomen with diffuse tenderness. She was slightly dehydrated. Peristalsis was inactive. Pelvic examination on this second admission was essentially negative, but on the following day a small, hard, movable, tender mass was felt in the cul-de-sac. The patient was not anemic, but a tarry stool was passed on the second day and the occult blood test was positive. Because of this finding, x-ray studies of the gastrointestinal tract were repeated, and this time showed a small duodenal ulcer. Two days later she again became distended and had cramping pain across the lower abdomen. These symptoms were quickly controlled by continuous Wangensteen suction through a Levine tube. It was believed that the duodenal ulcer failed to explain many of her findings so exploratory operation was carried out.

At operation, a suprapubic incision showed evidence of an old pelvic inflammatory process, but no evidence of the indurated mass that had been felt in the cul-de-sac. The abdominal organs were then methodically explored with the hand, and a hard, inflamed, "napkin-ring" lesion of the ileum, about 8 cm. from the ileocecal valve, was found. There were two enlarged lymph nodes in the adjacent mesentery but no evidence of metastasis elsewhere. The original incision was packed and a right rectus, muscle-splitting incision made to expose the right colon. The terminal 25 cm. of ileum, the ascending colon and about one-third of the transverse colon was then resected with a wide v-shaped portion of mesentery, and an aseptic end-to-side anastomosis between the ileum and transverse colon performed.

Operation was followed by a routine blood transfusion and continuous Levine tube suction of the stomach was employed until audible peristalsis was present over the abdomen (third day). She was given one dose of morphine postoperatively and subsequently was kept comfortable with small doses of codeine. Fluid balance was maintained by subcutaneous and intravenous fluids, using only enough saline to compensate for the amount lost by gastric suction. Convalescence was uneventful and she was dismissed walking on the eighteenth postoperative day.

*Pathological Report.* The specimen consisted of 25 cm. of terminal ileum, the cecum and ascending colon and approximately 8 cm. of transverse colon. In the terminal ileum, 6 cm. from the ileocecal valve was a constricting, indurated, discolored lesion which seemed to encircle the bowel completely. Three small lymph nodes were found in the mesentery adjacent to the lesion. On opening the small intestine, the lumen was found to contain old blood, and section through the constricting ring showed ulceration of the mucosa by a very firm, whitish tissue which appeared to extend through the entire wall of the bowel. Microscopic sections showed typical adenocarcinomatous invasion of the bowel wall extending deeply into the muscle layers and ulcerating into the mucosa. Sections of the lymph nodes showed evidence of chronic inflammation without neoplastic invasion. Diagnosis: Adenocarcinoma of the terminal ileum.

## SUMMARY

Despite its rarity, it is advisable for the general surgeon and other members of the profession to recognize carcinoma of the small intestine as a definite entity, and to keep it in mind in differential diagnosis of abdominal disorders.

Signs and symptoms are discussed which, when present, should enable one to make a diagnosis of carcinoma of the small intestine with a reasonable degree of assurance.

The accepted methods of treatment of these lesions are mentioned.

A case of carcinoma of the terminal ileum is reported.

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A TENSE anal haematoma, resulting from rupture of one of the anal veins, commonly occurs on the lateral aspects of the anal margin, and it is in this situation that excision of the swelling is most suitably carried out. The operation should be done when the haematoma is single and tense, before the overlying skin has become ulcerated and before the clot has discharged with risk of local infection.

From "Minor Surgery" edited by Humphry Rolleston and Alan Moncrieff (Philosophical Library).

# TETANUS OCCURRING IN IMMUNIZED INDIVIDUAL

## CASE REPORT

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ONE of the advances in immunology that is expected to benefit American soldiers is that of protecting them against tetanus by active immunization, a procedure advocated by Ramon and adopted by the French, British and American armies in World War II.<sup>4</sup> Reference has already been made to the possibility of tetanus occurring despite active immunization<sup>3</sup> as has, in fact, been reported among the British in the Middle East.<sup>1,5</sup> While the occurrence of but one case in an immunized American Soldier should not cast discredit on the procedure, it is believed that inasmuch as no such report has as yet appeared the following case is noteworthy:

### CASE REPORT

The patient, age twenty-eight years, a paratrooper on furlough, was brought to Columbia Hospital at 7:50 A.M., April 29, 1943. He had been found lying on the floor in his room in a pool of blood, unconscious, thirty minutes earlier. On admission he was conscious and stated that he had intentionally shot himself about 6:00 A.M. using a 0.22 caliber rifle. He further stated that he had been in the army a year and had had three tetanus toxoid injections. (This has been verified. He received 1 cc. of fluid tetanus toxoid on each of the following dates: May 9th, June 6th, October 23, 1942.) Examination revealed a restless, slender, white male in great pain and in shock. The skin was cold and clammy; the face, pallid. The temperature was 97°F., the pulse rate 88 a minute and of weak volume. The blood pressure was 70/50 and the respirations twenty-four a minute and grunting in character. Significant findings were otherwise confined to the abdomen where there was a small wound 1½ cm. to the left of the tip of the xiphoid process, from the history, the point of entrance of the bullet. Posteriorly,

there was another and larger wound 10 cm. to the left of the spinous process of the eleventh vertebra. The abdomen was flat, extremely tender and rigid. No peristalsis could be heard.

Taken directly to the operating room, pooled blood plasma administration was begun in an attempt to improve the patient's condition. It was soon apparent that the condition was not improving, however, and exploratory laparotomy through a left upper rectus incision was performed under nitrous oxide-ether anesthesia. A great deal of free blood was found in the abdominal cavity especially about the left upper quadrant. This blood was soaked up on sponges and wrung out into citrated saline solution for possible use. There was a laceration of the posterior border of the spleen extending up toward the hilum from which there was profuse bleeding. There was a through-and-through perforation of the left lobe of the liver, bleeding moderately. There was a rent in the gastrohepatic omentum just above and proximal to the pylorus. The lesser peritoneal cavity was explored through the gastrocolic omentum and revealed no injury to the mesenteric vessels or to the pancreas. There was no perforation of the stomach or of the intestines. Accordingly, autotransfusion was begun, splenectomy was performed, the rents in the gastrohepatic omentum and the liver were sutured. Cigarette drains were inserted into the splenic fossa and the lesser peritoneal cavity. Before closure, 10 Gm. of sulfanilamide powder and 5 Gm. of sulfathiazole powder were placed in the abdominal cavity. The patient had been given a total of 500 cc. of plasma and an autotransfusion of an estimated 800 cc. of citrated blood. At the conclusion of the operation the blood pressure was 120/60 and the pulse rate 110 a minute. The condition of the patient was considerably improved over that existing preoperatively.

The course of the patient during the next forty-four hours was pleasing. Fluids were

started by mouth after twelve hours. The day after operation the temperature was 99.3°F., the pulse rate 96 a minute and the respiratory rate 20. The patient was rational, co-operative, and conversed with other patients. The abdomen was flat and peristalsis was active. After initial catheterization he voided voluntarily. A stimulating dose of fluid tetanus toxoid was ordered at this time but was not readily obtainable and was not given until a day later.

His condition continued good until early the next morning of the second postoperative day, when at 4:00 A.M. the nurse noticed that the patient was awake, and seemed to be frightened. The pulse rate had risen to 120. By 5:30 A.M. the pulse rate had risen to 136. The patient seemed quite nervous. An intern was called who, suspecting hemorrhage, checked the blood pressure and found it to be 160/90. At 7 A.M. twitching of the facial muscles was first noticed and shortly thereafter the muscles of the arms and upper body became involved. Trismus was first noted at this time though may have been present earlier. The temperature was 100.2°F. rectally, the respiratory rate was 14 a minute, the pulse rate 164 a minute and irregular. The blood pressure was 170/90. The color of the patient was good. The patient was conscious, rational and said he had no pain. However, he appeared quite apprehensive. He was able to swallow liquids. The patient was not seen by the author until 11 A.M. at which time trismus and risus sardonius were present, there was rigidity of the upper arms and abdominal muscles, both hands were continuously twitching, the reflexes of the lower legs were greatly exaggerated, the respirations were somewhat labored and the patient was slightly cyanotic. The pupils were equal and contracted. He was still mentally alert. A diagnosis of tetanus was made. The patient was placed in an oxygen tent, was given paraldehyde by rectum and tetanus antitoxin, 60,000 units intravenously and 40,000 units intramuscularly. Despite paraldehyde, tonic contractions remained almost continuous. The respirations became labored. The pulse rate continued to rise. Tribromethanol in amylene hydrate (avertin) in a dose of 30 mg. per kilogram was given rectally following a generalized convulsion lasting six minutes at 2:30 P.M. The patient had another generalized convulsion one hour

later. Despite sedation, the patient continued to have convulsions, developed Cheyne-Stokes breathing and died at 7:05 P.M., sixty hours after admission. Permission for postmortem examination was denied by the family. Attempts to contact the proper army official for permission were unsuccessful. However, the abdominal cavity was examined at the funeral parlor by the senior army medical officer who ascertained that there was no evidence of peritonitis or of hemorrhage.

#### COMMENT

The absence of bacteriological confirmation leaves this case open to question. Clinically, however, the diagnosis of tetanus seems well established and was concurred in by all including military authorities who saw this patient. Rabies, strychnine poisoning, and transfusion reaction were all considered in the differential diagnosis. The first two conditions can be ruled out largely by the history. The use of whole blood transfusions following plasma administration have been responsible for reactions but the symptoms differ markedly from those in this case. We have been able to find no case of reaction following autotransfusion after plasma administration nor would we expect it to occur. The incubation period in this case was short but has been reported of even shorter duration.<sup>6</sup> In these cases the prognosis is more grave than when the incubation period is prolonged.<sup>2</sup>

Long<sup>4</sup> has outlined the current Army tetanus immunization procedure which, briefly, consists of three subcutaneous injections of fluid tetanus toxoid at intervals of three weeks followed by a single stimulating dose at the end of one year or prior to departure for a theatre of operations. He further states, "an emergency stimulating dose of toxoid is administered upon the incurrence of wounds or severe burns on the battlefield, at the time of secondary operations or manipulations of old wounds, or at any other time when danger from tetanus is considered to be a possibility. Antitoxin is not administered for prophylaxis unless there is

reason to doubt that the individual in question had previously received at least the initial series of toxoid injections."

Boyd<sup>1</sup> has shown that in active immunization there is an interval between the stimulation of the reticulo-endothelial system and the formation of antitoxin, antitoxin production not beginning until the fifth day and not reaching its peak until the tenth to fourteenth day. He concluded that, while in general active immunization may be expected to afford protection against tetanus in all wounded receiving adequate surgical treatment, there are three possibilities in which active immunization might fail: (1) Some individuals may not react to immunization; (2) in some, the circulating antitoxin may be small in quantity and may remain so for a week after the injury, and (3) in badly wounded and shocked subjects antitoxin production may be less.

Because of this Boyd proposed (which proposal the British Army has adopted) that passive immunization (antitoxin) be administered at the time of injury to cover the above possibilities. The British routine thus differs from the American in that the former now relies upon both active and passive immunization for tetanus.

It is unfortunate that the patient reported did not have a prompt stimulating dose of toxoid. In view of the short incubation period and in light of the time lag for further antitoxin formation mentioned above, it is difficult to conceive of any benefit in this case by a more prompt administration. For that matter, in view of the rapid

onset of trismus and the rapidly fatal course it is doubtful if the usual prophylactic dose of tetanus antitoxin would have altered the outcome. Presumably it might in those cases in which the field was a bit less fertile and conditions a bit less favorable for growth of the *Clostridium tetani* than apparently existed in this case. Accordingly, for the most complete protection, the use of passive immunization at the time of injury should be considered.

#### SUMMARY

1. A case of probable tetanus occurring in an American soldier previously immunized with three doses of fluid tetanus toxoid is reported.

2. Tetanus under favorable conditions for bacterial growth, i.e., shock, extensive tissue destruction, hemorrhage, etc., may develop before any rise in the circulating antitoxin level from the stimulating dose of toxoid is obtained.

3. It is suggested that in all cases of shock, severe blood loss, extensive tissue damage, etc., tetanus antitoxin be administered to supplement active immunization.

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# MAXILLARY SINUSITIS WITH OPTIC NEURITIS

## CASE REPORT

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IT is the opinion of many observers that diseases of the paranasal sinuses seldom cause retrobulbar neuritis and optic neuritis. Undoubtedly, many operations on the sinuses have been needlessly performed in an endeavor to improve the eye condition. Nevertheless, a careful study of the paranasal sinuses is indicated when retrobulbar or optic neuritis occurs.

It is the writer's impression, gained from clinical experience and from reports in the literature, that when the optic nerve is affected as a result of sinusitis, the disorder is generally in the sphenoid and ethmoid sinuses. Some contend that extirpation of the posterior sinuses is justifiable even though a pathological condition cannot be demonstrated preoperatively.

Until disease of the sinuses has been established to the satisfaction of the examiner, there is no need for great haste in performing an operation. Conservative measures should be tried, and careful and thoughtful planning should precede surgical intervention.

## CASE REPORT

This is the case history of a white woman, married, age thirty-four, who had been under observation since July 29, 1942.

Following the extraction of the right upper bicuspid and first molar teeth she developed an acute maxillary sinusitis. At the first examination she had a large fistulous tract leading from the alveolar ridge into the right antrum and through the fistula pus escaped and granulation tissue protruded. The temperature was 99.6°F., the leucocyte count 12,350, and the serology test was negative. Roentgenograms of the sinuses revealed an opacity of the right maxillary sinus apparently due to secretions and thickened mucous membrane.

Following sulfonamide therapy and conservative measures, a Caldwell-Luc operation was performed and the alveolar defect was closed with a sliding flap from the palate. Thick pyogenic membrane and granulation tissue were removed from the antrum. Later a small fistula persisted necessitating a second operation on the alveolar ridge. Healing was slow but complete and she was discharged October 15, 1942.

She remained well until the first week in December, 1943, when she returned complaining of aching through the right side of the face and lancinating pain in the right eye with rotation of the globe. At this time examination of the nose was negative. Five days later she stated that the vision of the right eye was impaired. Visual acuity was found to be reduced to counting fingers at one meter. The nasal margin of the right optic disc was obliterated and swelling of the nerve head was noted. The retinal vessels were tortuous and the veins engorged but no hemorrhages or exudates were seen.

The loss in vision was so rapid that a visual field was not obtained until after the focus of infection had been eradicated and as the acuity was approaching normal. (The peripheral and central fields then showed no abnormality other than an enlarged blind spot.)

Vision rapidly decreased until only light perception was admitted. A neurological examination was essentially negative. Study of the remaining teeth revealed nothing other than a non-vital upper right incisor.

Typhoid-paratyphoid vaccine in increasing amounts was administered intravenously but although the constitutional reactions were excellent the visual acuity improved to only 6/60 (Snellen). During the eight-day period that foreign protein was given a little yellowish mucopus was noted twice in the right middle meatus. The maxillary sinus was irrigated via the inferior meatus and the returning fluid

was essentially clear. Several sinus displacement treatments (Proetz) were then given.

Radiographic examinations of the paranasal sinuses and skull revealed only a homogeneous clouding of the right maxillary sinus. Further study following the instillation of lipiodol into the right sphenoid sinus showed no evidence of a filling defect.

Inasmuch as only slight improvement followed conservative measures, it was considered best to reopen the antrum and at the same time investigate the ethmoid cells and the sphenoid by the transantral route.

On exposing the canine fossa, dense fibrous tissue was found to be closing the former opening and also extending into the antrum. The canine opening was enlarged and one could then see a large fibrous mass filling the sinus. On entering this dense tissue, thick yellow pus was encountered. After complete removal of the contents of the antrum, the ethmoid cells and the sphenoid were explored but these structures appeared to be normal in every respect.

Hemolytic staphylococcus albus was grown from the pus in the antrum. Microscopic examination of the fibrous mass showed very dense scar tissue with areas of infection.

The postoperative course was uneventful and after seven days the vision was 6/10; except for blurring of the nasal edge of the optic disc, the fundus appeared normal. Two

weeks following the operation the corrected vision of the right eye was 6/6.

The pathological condition noted at the time of the operation and the subsequent rapid improvement after removal of the infected tissue indicate that the focus of infection was within the right maxillary sinus. The return of clear solution upon irrigating the sinus preoperatively was probably due to the point of the trocar lying between the medial wall of the antrum and the fibrous mass.

#### SUMMARY

While conservative treatment resulted in slight improvement in the visual acuity, rapid betterment and ultimate normal vision followed the removal of infected tissue from the maxillary sinus.

It is fair to conclude that the infection within the antrum was the cause of the optic neuritis.

Conservative measures should be instituted while the search for foci of infection is progressing but once a focus is definitely established it must be eliminated without delay.

Careful investigation and planning should precede nasal surgery.



# OSTEIOD OSTEOMA OF MID-SHAFT REGION OF FEMUR\*

## CASE REPORT

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THOSE experienced in the surgery of bone have from time to time encountered rarifying and sclerotic lesions, especially in the shaft of the long bones, which clinically were the seat of pain. These lesions resembled infectious osseous changes in the roentgenogram, but failed to yield cultures of micro-organisms. It has often been assumed in such cases that insufficient material was obtained to yield a positive culture or that infection, present at one time, had disappeared by "autosterilization," a process known to occur in soft tissue abscesses. Many of these lesions are referred to as Garre's sclerosing, non-suppurative osteomyelitis. However, since Garre's original description was published in 1891, prior to the use of roentgenographic methods in the diagnosis of bone lesions, justifiable doubt exists as to the nature of the original "Garre's osteomyelitis." In practice, at the present time, the term refers to a sclerosing, non-suppurative, infectious lesion of bone from which micro-organisms, usually staphylococci, are cultured with regularity. Later, several French authors have referred to "tumoral form of chronic osteomyelitis." In the reports of these latter patients (Loiret and others), cultures of micro-organisms were not obtained. Phemister, in this country, has described cases of this general type of bone disorder which failed to yield cultures for micro-organisms.

In recent years, Jaffe, in a series of papers, has designated as "osteoid osteoma" a lesion of bone which fits into this general category and which is characterized roentgenographically by a circumscribed area of rarification, either medullary or subcortical,

surrounded by a much larger zone of osteosclerosis. These lesions, collected and clearly described by Jaffe, yield no cultures of micro-organisms, are non-inflammatory and microscopically are composed of osteoid tissue, between the seams of which fibrous marrow is to be found. The older lesions are composed of closely applied, thickened seams of osteoid and appear in the roentgenogram as more dense than the surrounding reactive bone. There are no inflammatory cells to be found in these lesions. The opinion of this author is that this is an osteoid tumor which replaces the normal osseous architecture. This conclusion is based upon the dual finding of negative cultures for bacteria and the characteristic microscopic appearance of a circumscribed type of tissue replacing the osseous architecture.

The following picture of the clinical diagnostic and roentgenographic features of osteoid osteoma is summarized from the most recent article of Jaffe and Lichtenstein: The lesion occurs usually in an adolescent or a young adult in whom the complaint is of well localized deep pain usually of months' duration. Signs of inflammation as local heat and swelling are usually absent and the patient has not experienced exacerbations of temperature. The clinical laboratory findings are all normal, including the sedimentation rate of the red blood cells. Of course, the usual serological and dermal tests for syphilis and tuberculosis are negative. The x-ray appearance is the most characteristic feature of the disorder. The lesion is one usually of reduced density surrounded by sclerosis which accounts for the usual labeling of the

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lesion as a bone abscess by the roentgenologist. However, it is smaller than the average pyogenic abscess of bone, usually

Packer Hospital stating that she had had "pain off and on for the past ten months in the mid-portion of the right thigh." Especially in the

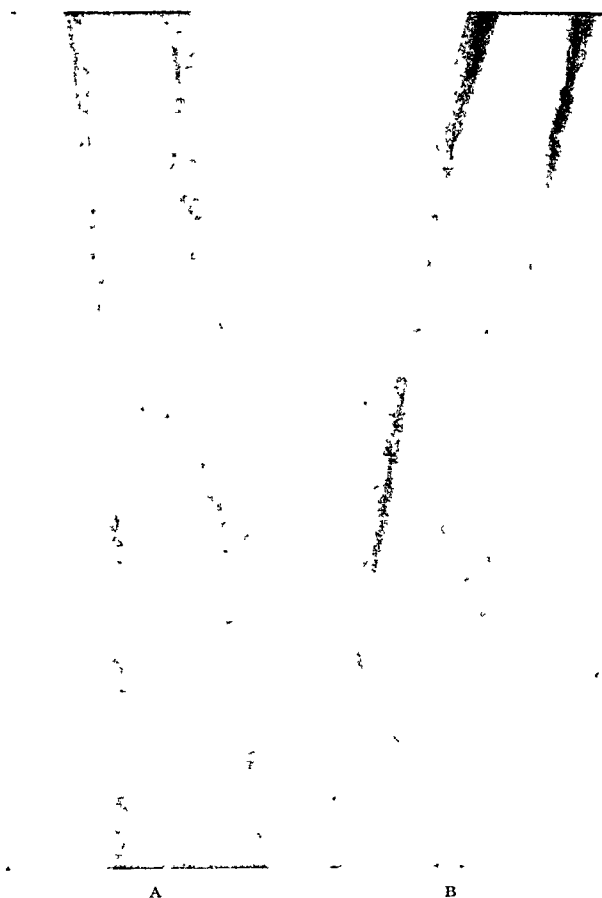


FIG. 1. A, roentgenogram showing radiolucent area in mid-portion of femoral shaft prior to operation. Note that this is surrounded by a certain amount of sclerotic bone, an appearance that would be identical with a chronic bone abscess of pyogenic origin. B, appearance of same area in the femoral shaft ten months following operation. Note the restitution of osseous architecture.

being  $\frac{1}{2}$  to 1 cm. in diameter. The area of reduced density is surrounded by a greater or less restricted zone of osteosclerosis which may even include a fusiform periosteal reduplication if the lesion is subcortical.

The case described in this report coincides with all the characteristics of osteoid osteoma. It is an example of the variant of this lesion occurring in the mid-shaft region of the long bones.

#### CASE REPORT

The patient, female, aged nine, presented herself to the Guthrie Clinic and Robert

four months immediately preceding her appearance at the clinic this pain was much worse and during this time would even awaken her from a sound sleep. The patient was quite definite that there was and had been no pain in the hip, knee or elsewhere.

Examination showed no positive findings except a fusiform enlargement which was definitely palpable in the mid-portion of the right femur. This enlargement was easily felt inasmuch as the child was slender and her muscles had not excessively developed. There was no limitation on passive motion at either hip or knee. X-rays showed an area of sclerosis,

which appeared to be a thickening of the cortical shadow which included encroachment of this shadow upon the marrow space. In the center

microcrystals of sulfathiazole were packed into the medullary canal at this level. The wound was then closed tightly with interrupted



FIG. 2. Microphotograph of material removed by a gouge from the radiolucent area. Seams of osteoid (o) are to be seen, all interspersed with a heavily nucleated vascular connective tissue (pre-osteoid?). Note the absence of cells which would indicate acute inflammation.  $\times 125$ .

of this thickened sclerotic area in the bone there was a radiolucent area approximately 2 cm. in diameter. The opinion of the roentgenologist was that this represented "infection with abscess formation." (Fig. 1A.)

The examination of the blood revealed normal findings, including a sedimentation rate of 10 mm.

An operative approach was made to the mesial surface of the right femoral shaft through a small diagonal three-inch mid-thigh incision on the mesial surface of this structure. The bone was approached along the intermuscular septum between the vastus medialis and the rectus femoris. No difficulty was experienced in identifying the area as seen in the x-ray, inasmuch as the operation was performed in a bloodless field following the application of a constrictor around the groin. Eight drill holes were placed in the bone at the level of the fusiform enlargement. The bone at this level was not sclerotic but gave one the feeling of boring through material of the consistency of soft wood. No pus escaped from any of the drill holes. The area of decreased density was opened. This contained soft, gritty, fibrous-like material. Because of the possibility of the infectious nature of this lesion, 2 Gm. of the

stitches of cotton for the fascia and for the subcutaneous tissues.

Cultures made of the material removed from the area of decreased density were reported as showing "no growth." The sections of bone showed a circumscribed concentration of osteoid tissue interspersed between thickened trabeculae of normal bone. There was elsewhere in these sections a copious amount of fibrous marrow. There were no inflammatory cells in evidence.

Following the operation, the patient's temperature exceeded normal by only one-half degree on two successive days. She never had significant complaint at the operative site and there was no subsequent evidence of inflammatory swelling other than the small amount of tenderness associated with normal wound healing. The stitches were removed at the usual time. The patient was instructed to bear weight cautiously on this leg for six weeks and to return to the clinic at the end of that time. On two follow-up visits at six-week intervals following the operation, the patient stated that she had been fully relieved from pain and on the last occasion had been bearing weight unaided for four weeks without event. The patient has remained normal for eighteen

months following the operation. A roentgenogram taken ten months following operation is shown in Figure 1B.

#### COMMENT

The treatment of this condition usually is by open operation inasmuch as the surgeon must make a diagnosis of the nature of any osseous lesion. Positive proof of this lesion or of any lesion of bone, for that matter, can be obtained only after cultures have been made for micro-organisms and tissues removed and examined microscopically. All the cases described by Jaffe and Lichtenstein were relieved following either curettage or excision of the lesion. In our case, curettage was performed and several drill holes were placed through the neighboring reactive bone. The patient has had no recurrence of symptoms. A microphotograph of a portion of the tissue removed at the curettage is shown in Figure 2.

This case represents the most characteristic site of occurrence of this lesion, i.e.,

in the mid-shaft region of the long bones. Two-thirds of the cases of Jaffe and Lichtenstein occurred in the long bones.

#### SUMMARY AND CONCLUSIONS

A case of osteoid osteoma, a nonsuppurative, localized benign tumor process composed of osteoid tissue occurring in bones, is described. This entity is a recently delineated disorder (1935, Jaffe) of bone. It is of importance in the differential diagnosis of chronic osteomyelitis.

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# SPONTANEOUS RUPTURE OF THE RECTUS ABDOMINUS MUSCLE

## THE RESULT OF INDIRECT MUSCULAR EFFORT

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MEDICAL CORPS, ARMY OF THE UNITED STATES

THERE has appeared occasionally in the medical literature reports on hematoma of the abdominal wall, the result of rupture of the rectus abdominus muscle, deep epigastric artery or vein. Maydl, reviewing the literature, described fourteen cases up to 1880. Wahlgemuth reported 127 cases up to 1923.

Since then, the subject has received attention mostly from military surgeons, who report cases occurring in young males, particularly recruits, in the armed forces in which the condition was produced by either direct physical trauma or physical effort.

At the present time with so many young men entering the armed services from a relatively sedentary civilian life, it is only natural that many additional cases should develop. In peace times, the diagnosis was not readily appreciated, and many patients were operated upon for acute surgical conditions of the abdomen, particularly acute appendicitis. However, in the armed services the history of trauma, or physical effort is easily obtained so that the diagnosis is more readily established.

The symptoms are fairly characteristic. The onset is usually sudden with pain in the abdomen following physical effort such as scaling the wall on the obstacle course, or other effort associated with the physical training program. There is muscle rigidity and extreme tenderness so that the patient moves with a great deal of caution to protect the abdominal muscles. Swelling soon develops followed by ecchymosis of the skin.

The hematoma usually develops on the right side in a right-handed person as

he exerts more strain on that side. It usually appears in the weakest portion of the muscle; namely, that portion below the semi-circular line of Douglas where the aponeurotic sheath on the posterior surface of the muscle is absent and where the muscle is only weakly supported by the transversalis fascia.

The following are case reports of rupture of the rectus abdominus muscle on the right side in young men resulting from indirect physical effort. None of these patients gave a history of direct violence.

### CASE REPORTS

CASE 1. A white youth, eighteen years of age, who had been in the service one month, while pulling himself up over the scaling wall of the obstacle course, noticed a sudden pain and tightening of the muscle in the right lower quadrant. There was no vomiting but some nausea. The pain continued and he had to stop exercising and was subsequently brought into the hospital. There had been a previous attack of right lower quadrant pain about a year ago which was diagnosed as appendicitis, but an appendectomy was not performed. He stated this pain came on more suddenly right after the exertion and was different from the pain of his previous attack.

Examination showed a bulging of the lower portion of the right rectus muscle. The area was excruciatingly tender and he would not let the examiner touch it. The right inguinal ring was open but there was no impulse. There was only slight ecchymosis present. The white blood count was 10,750 with 84 per cent polymorphonuclear leucocytes and 14 per cent lymphocytes. Rectal examination was negative.

A diagnosis of ruptured rectus abdominus muscle was made and it was decided to treat the patient conservatively. Under bed rest, cold and later hot applications the patient

improved greatly. The mass decreased in size, the pain and tenderness and ecchymosis disappeared and the patient left the hospital after three weeks' confinement.

CASE II. A white youth, nineteen years of age, who had been in the service one month, was taking calisthenics and while performing some "push-ups" noticed a sudden pain in the muscle of the right lower quadrant. He stated that it felt like "a rubber band snapped." He stopped exercising and after a rest went about his duties that day even though he did have pain in the muscle. He did not exercise for two days but on the third day he tried the obstacle course and while pulling himself up the wall he noticed a sudden and severe pain in the right side. The pain was so severe that he could not arise and was admitted into the hospital. There was some nausea but no vomiting. There was no history of previous right lower quadrant pain.

Examination revealed excruciating tenderness over the right rectus muscle over its lower portion. There was no ecchymosis, but there was a slight bulging of the muscle. The white blood count was 12,750 with 81 per cent polymorphonuclear leucocytes and 17 per cent lymphocytes. Rectal examination was negative and there evidently was no peritoneal irritation.

Under conservative management the condition entirely cleared in ten days, at which time the patient left the hospital.

CASE III. A white adult, thirty years of age, who had been in the service one month, was scaling the wall on the obstacle course and as he was lifting himself up, felt a sudden severe pain in the muscle of the right lower quadrant. He stated that it felt "as if tissue paper had been torn." He definitely stated that he did not come in contact with the wall against his abdomen, but felt this pain as he lifted himself up the wall. The pain was so severe that he had to let go and dropped to the ground.

He was brought to the hospital complaining of severe pain in the rectus abdominus muscle, and soreness over the suprapubic area. Over this area there was a freely movable mass which appeared to be clotted blood. There was no previous history of right lower quadrant pain. There had been no urinary disturbances or bowel irregularities at any time, and there was no loss of weight at any time.

Examination revealed a large mass in the

area of the rectus muscle extending over the suprapubic region. There was a large extravasation of blood into the tissues of the penis and scrotum. The mass was not palpable per rectum.

This evidently was a fairly large hemorrhage. In the two previous cases the primary injury was to the muscle. In this case there was the additional injury to the deep epigastric vessels, probably the vein. The red blood cells were 5,240,000. Hemoglobin was 75 per cent and the white blood count was 11,700 with 78 per cent polymorphonuclears and 20 per cent lymphocytes.

Due to the amount of hemorrhage, the question arose as to whether it would be advisable to evacuate the clot and ligate the deep epigastric vessels. It was decided to treat the patient conservatively since his condition was excellent, and since the physical signs of hemorrhage were out of proportion to the patient's condition. This led us to believe that the vein had been injured rather than the artery and it was decided to treat this patient in the same manner as the others. His convalescence lasted ten weeks, after which time the mass and the entire ecchymosis had disappeared.

#### SUMMARY AND CONCLUSIONS

1. Three cases of spontaneous rupture of the right rectus abdominus muscle are presented.

2. All three cases were in young men who had been in the service but one month.

3. All three cases occurred as a result of indirect violence due to sudden muscular contraction while scaling the wall on the obstacle course.

4. All cases were treated conservatively with complete recovery. The question of surgery arises in those cases of severe hemorrhage due to injury of the deep epigastric vessels such as was encountered in Case III. While the patient had an uneventful convalescence, it might be better judgment in such cases to remove the clot and ligate the vessels. This procedure would undoubtedly reduce the time of hospitalization.



# INTERSTITIAL VENTRAL HERNIA INVOLVING THE SMALL INTESTINE

## CASE REPORT

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INTERSTITIAL hernia is a relatively rare condition. According to Lower and Hicken, only 587 cases of all types have been reported in the literature. The infrequency and diagnostic difficulties associated with this condition are illustrated by the following case report:

### CASE REPORT

This patient was a sixty-four year old colored female who had suffered from stomach trouble of a vague nature throughout her entire life. Twenty-two years previously an abdominal laparotomy had been performed at another hospital presumably for a gallbladder condition. However, at the time of operation, a ruptured peptic ulcer was found. This was repaired, the abdomen was closed, and the patient recovered uneventfully.

For a period of eight years following this operation, the patient was free of symptoms. She then began to suffer from attacks of dull, gripping abdominal pain starting on the right side and spreading over the entire abdomen. These attacks were associated with marked nausea and some vomiting. The emesis consisted of food and bile-stained fluid. Further, the patient noticed that a "hard lump" developed near her old right rectus scar in association with these attacks. Ordinarily, these attacks would last from two to three days, occurred about once or twice a month, and were associated with a slight temperature.

The past history was negative except for an attack of jaundice eight years previously and the presence of hypertensive and arteriosclerotic heart disease of a mild degree of three years' duration.

The patient was first seen in the out-patient department of Michael Reese Hospital (The Babette and Emmanuel Mandel Clinic) on October 23, 1942. At this time a melon-sized, oval mass was felt in the right lower quadrant

of the abdomen. It was solid in its upper pole, at which point it met with the right costal arch. The impression of the examiner was that this mass represented an ovarian cyst although a mass of uterine or renal origin was also considered. A few days later the patient was seen in the Genito-Urinary division of the Mandel Clinic. At this time a rounded mass was felt on the right side of the abdomen extending from the ribs to the iliac crest. This mass was described as being round in shape, semi-fluctuant in consistency and was felt anteriorly but not posteriorly. The examining urologist expressed the opinion that the mass represented either an enormous hydrops of the gallbladder or a large bowel neoplasm. Urinalysis and gynecological examination revealed no significant findings.

The patient entered Michael Reese Hospital for further study on November 9, 1942. Examination of the abdomen at this time revealed a sausage-shaped, soft mass on the right side of the abdomen, extending from the right iliac crest to the right costal arch. The mass was fixed and moderately tender. A well healed right rectus scar was present just medial to the mass. A palpable defect was present in the lower part of this scar suggesting the possibility of a ventral hernia. It was the impression of the examiner that the mass lay in the anterior part of the abdomen and that it was of a cystic consistency. It was approximately 10 cm. in width and 20 cm. in length. Peristaltic sounds were easily heard over the mass. The remainder of the abdominal examination revealed no significant findings.

X-rays of the gallbladder and kidneys were found to be normal. Barium meal studies of the upper gastrointestinal tract revealed no pathological condition involving either the stomach or duodenum. However, during the routine examination of the roentgenographic films taken at this time, it was noted that a few loops of small bowel apparently lay on the outside of the abdominal wall.

Following this lead, small intestinal studies were made with x-ray films being taken three hours following a barium meal. Examinations of these films immediately resulted in making the proper diagnosis of interstitial hernia involving the small bowel; for loops of barium-filled small bowel were clearly seen to lie between an apparent split in the muscle sheaths of the right lateral abdominal wall. (Fig. 1.) No obstruction was noted. Barium enema studies revealed no intrinsic abnormalities involving the colon.

At operation one week later, several layers of small bowel enclosed in a hernial sac were found lying between the external and internal oblique muscles. The herniation was found to have occurred through a defect through both the transversalis and internal oblique muscles and fascia. Numerous adhesions were present inside the sac. By careful dissection the loops of small intestines were freed and replaced into the peritoneal cavity. The peritoneum was closed with a continuous suture and the hernia was repaired in the usual fashion. The post-operative course was uneventful.

#### COMMENT

Interstitial hernias are defined as hernias in which the hernial sac lies either between the transversalis fascia and the transversalis muscle, or between the internal oblique muscles and the external oblique aponeurosis. Together with properitoneal and superficial hernias, they form the group of hernias known as interparietal hernias. Interparietal hernias almost always occur in the inguinal region and are said usually to follow the course of the spermatic cord to their position between the various layers of the abdominal parietes. A thorough review of the American literature failed to reveal a single case of interparietal hernia of other than inguinal location. In view of this and in view of the diagnostic difficulties involved in such a case, it was thought that reporting this case would be worth while. The importance of x-ray studies of the small bowel in cases in which such a diagnosis is being considered is emphasized. Further, as in this case, careful examination of a flat plate of the abdomen even without a previous barium meal is helpful in establishing the diagnosis.

This is important in cases in which intestinal obstruction is a factor and when it would be unwise to administer barium.

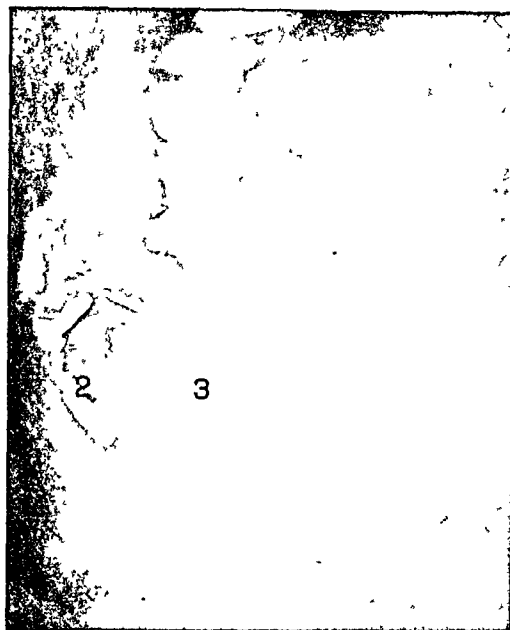


FIG. 1. Interstitial ventral hernia lying between the internal and external abdominal oblique muscles. The afferent and efferent loops of the hernia are clearly shown: 1, twelfth rib; 2, loops of barium filled small bowel in hernial sac; 3, iliac crest.

#### SUMMARY

A case of interstitial ventral hernia of the small bowel is presented because of its rarity and because of the diagnostic difficulties associated with this condition. Although over 500 cases of interstitial hernia of the inguinal region have been reported, a review of the American literature failed to reveal any cases of ventral hernia of the interstitial type. The importance of x-ray studies, both flat plates and small intestinal studies following a barium meal, is emphasized as being of prime importance in establishing a diagnosis.

We wish to thank Dr. Jacob Meyer, of the Department of Medicine, and Dr. Robert A. Arens, of the Department of Roentgenology, of the Michael Reese Hospital, for their help and criticism in preparing this report.

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# New Instruments

## AN AID IN CASTING OF FRACTURES\*

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BROOKLYN, NEW YORK

**A**PPPLICATION of plaster casts to fractures is such a commonplace procedure that one is occasionally

be passed over lightly. The frame can be folded to occupy but a little space and left in the corner of the office closet or fracture

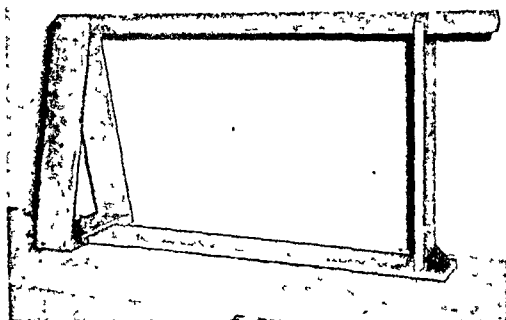


FIG. 1.

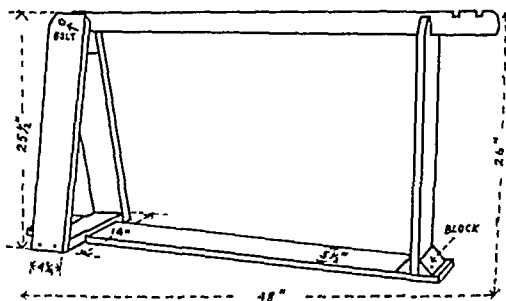


FIG. 2.

FIGS. 1 AND 2. The frame showing simplicity of construction and assembly.

annoyed by the need for repeating the operation in recent and older fractures that require a new cast for various reasons.

A cast may have to be replaced for one of the following conditions: (1) Sagging at the fracture site; (2) cast not affording adequate immobilization; (3) lack of dorsiflexion of the wrist or ankle; (4) inadequate inversion of the foot; (5) pressure points produced where assistants may inadvertently use finger tips rather than the flat of the hand to support the fractured limb, and (6) cast weakness in the vicinity of joints where the instability of hand support permits motion before the cast has set.

During the past four years the author has employed a frame he had built, which eliminates the conditions enumerated. It does away also with the need of an assistant to help in the application of the cast, and at the present time this factor cannot

room of the hospital; it may indeed be welcome anywhere one may be called upon to apply a cast. Furthermore, it requires no essential war material in its construction and can be built by anyone who can obtain a little lumber and a saw and saves considerably on the cost of materials needed to replace the cast if and when such a replacement becomes necessary. The frame is applicable to fractures of the upper and lower extremity and its operation is so simple that the writer has long hesitated to offer it as an aid in fracture treatment.

*Construction of the Frame.* Figures 1 and 2 show the frame and the plan of construction with the dimensions used. The two horizontal arms are each 48 inches in length, the upper of 3 by 1½ inch stock, while the lower horizontal is 5½ by 1¼ by 48 inches. The legs of the triangle each measure 25½ by 4¼ by 12 inches. The

\* From the Surgical Department, Coney Island Hospital.

base of the triangle is 14 inches long,  $4\frac{1}{4}$  inches wide and is made of  $1\frac{1}{2}$  inch stock and is grooved to allow the assembled triangle to slide on the lower horizontal arm. When this happens the upper horizontal arm will extend well beyond the vertical bar making of it a suitable suspension bar for fractures of the upper extremity. The upper bar is fixed with a bolt and washer to the apex of the triangle so that it may be folded down when the frame is not in use. The vertical bar is fixed permanently near the end of the lower horizontal bar or it may be hinged to it, in which case it will be necessary to supplement the hinge with a right angle bracket to steady the vertical bar when in use. The upper end of the vertical bar is grooved so as to receive the horizontal bar. Two shallow grooves are cut on the upper edge of the upper horizontal arm in order to catch the slings used in supporting the upper extremity as in Figure 3.

extremity, a clamp is applied to the base of the triangle fixing it firmly to the surface on which the frame rests. (Fig. 3.)

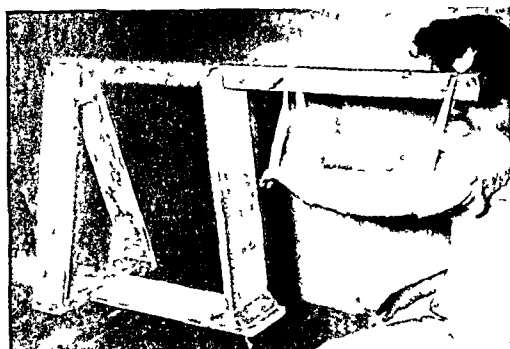


FIG. 3. Application of shoulder spica. Note ease with which dorsiflexion of the wrist can be maintained.

*Method of Operation.* The author has employed sugar tong splints for most fractures below the elbow. In such cases it is often necessary to suspend the limb where the patient cannot be made to hold it up and where the aid of an assistant is



FIG. 4. Supporting the lower limb preliminary to correction of foot drop and eversion.



FIG. 5. The sling line applied to the great toe making the necessary corrections before the plaster bandages are applied.

When used in casting the lower extremity, the frame is stabilized by resting the buttock of the affected side on the upper end of the lower horizontal arm after the limb is passed through the triangle. (Fig. 5.)

When the frame supports the upper

not available. The frame has been found to be particularly applicable in fractures of the humerus in which the application of a shoulder spica is indicated. In such cases the horizontal upper bar is made to

extend beyond the distal vertical piece and the limb is suspended as shown in Figure 3. By adjusting the suspending muslin or gauze supports, the desired degree of abduction of the arm is obtained while the patient is made to sit upon a screw top stool which can be raised or lowered as desired. By proper adjustment of the hammock supporting the hand, the desired degree of dorsiflexion of the wrist may be obtained and held until the plaster sets. Figure 3 also shows the ease with which a shoulder spica may be applied without extra help.

In fractures of the lower extremity the limb is dressed with the necessary length stockinette and wadding and passed through the triangle as shown in Figure 4. Muslin or bandage hammocks are applied to suspend the extremity from the horizontal upper bar. These supports are applied in

proper relation to the fracture line in order to eliminate posterior sagging or anterior bowing as may occur when the hammocks are either too far or too close to the level of the fracture. (Fig. 4.) An oblique tractor line is now applied by throwing a loose loop about the great toe and anchoring the proximal end of the line to the apex of the triangle as shown in Figure 5. This simple measure will correct any tendency to foot drop as well as eversion of the foot in the course of casting. Lateral or medial bowing at the fracture site is unlikely to occur because the limb hangs directly beneath the straight horizontal upper bar. At this point the limb is ready for application of plaster bandages and when this is completed and the cast set, the loop over the great toe is released, suspending lines are cut and the operation completed.



# A NEW NEUROSURGICAL INSTRUMENT

## A COMBINED SUCTION AND ELECTROCOAGULATION TIP

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THIS instrument was designed to coagulate bleeding points quickly and effectively, particularly those

one of the valuable hands of the assistant. With suction on the bleeding point, the vessel can be sucked up into the opening

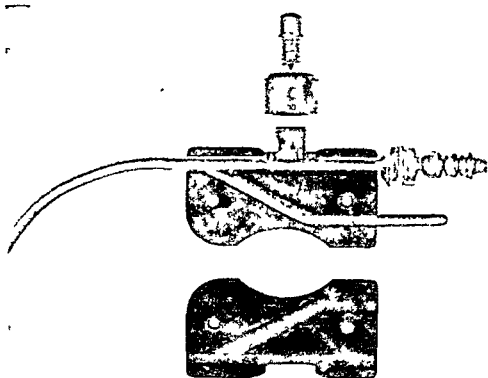


FIG. 1. The instrument is shown dismantled. The solid brass rod is soldered directly to the suction tip which is directly at the end of the rod on the left of the illustration. (This tip does not appear in this cut.) The upper portion of the tip is enclosed in a hard rubber or bakelite jacket. The rubber cap insulates the operator's thumb, which opens and closes the suction current by pressing on the small nipple.

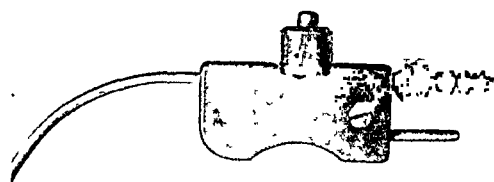


FIG. 2. The instrument is pictured assembled and is light and not cumbersome.

in the depths of a tumor bed. Not infrequently, the operator encounters a serious bleeder which fills the cavity and obstructs the field of vision. The cavity must be sucked dry to locate the bleeding point which is then grasped with a bayonet forceps. The operator then usually asks the assistant to touch the forceps with the electrocoagulation tip. This maneuver must be executed quickly and requires proper timing between operator and assistant. This is not always successful as many neurosurgeons can testify.

The instrument presented combines suction and electrocoagulation so that the operator, with a single hand, can carry out this maneuver. Obviously, this releases

of the tip, rendering the field dry. Simultaneously, the foot switch allows the electrocoagulating current to coagulate the vessel drawn up into the suction tip opening. Should this be undesirable, the instrument may be simply touched to the bayonet forceps, which can grasp the vessel in a dry field.

An additional feature is offered in that the smoke from the coagulated tissue is immediately sucked out of the field, making visibility clearer. The instrument may also be used on bleeding scalp vessels and bleeding epidural spinal veins.

The instrument is pictured in Figures 1 and 2. In Figure 1 the instrument is dismantled, showing its simple construction. One end of the electrocoagulation circuit is directly soldered to the suction tip in the form of a single brass rod which plugs into a small socket attached to one end of the electrocoagulation wire. The

small, hard rubber cap is designed to prevent short-circuiting of the current through the glove of the operator. The nipple fitting into the top of the cap has a small coiled brass spring about it. This nipple opens and closes the suction current.

Figure 2 shows the instrument assembled.

Sterilization is found to be satisfactory

by immersion for fifteen minutes in formalin and boric acid solution. If the hard rubber parts are constructed of bakelite, the instrument can withstand autoclaving.

I wish to express my sincere appreciation to Mr. James Davis of the Temple University Hospital machine shop who worked out the mechanical features of the instrument.



IN this war abdomino-thoracic injuries due to fragments of high explosives are probably less grave than those due to crushing force or the effects of blast.

From "War Medicine—A Symposium" edited by Winfield Scott Pugh (Philosophical Library).

# A DEVICE FOR THE INTRODUCTION OF A SELF-RETAINING CATHETER INTO THE BLADDER

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AND

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A SUPRAPUBIC catheter in the bladder is now a well recognized substitute for the former cystostomy

We have devised and prepared a trocar which can be removed over the Foley catheter. This is done by sawing a notch

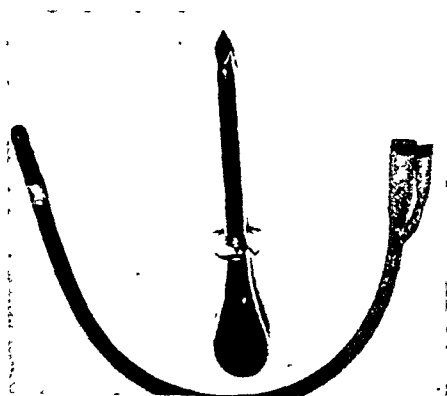


FIG. 1.



FIG. 2.



FIG. 3.



FIG. 4.

FIG. 1. Illustrating the trocar and catheter.

FIG. 2. Illustrates the groove in the trocar.

FIG. 3. Illustrates the method of slipping the trocar over the end of the catheter.

FIG. 4. Illustrates the method of slipping the trocar over the end of the catheter.

operation to drain the bladder before prostatectomy.

During the last five years, we have used only a self-retaining suprapubic catheter in the bladder. The purpose of this communication is to describe a simple instrument for introducing such a catheter into the bladder.

In our hands Pezzer catheters have been unsatisfactory as they have been accidentally pulled out. Since we began the use of the Foley catheter, none has come out.

along the length of the trocar. The smaller tube of the Foley catheter can slip through this groove or notch. If an ordinary trocar is used, it must be left on the rubber tube and strapped to the belly until the second stage is done; or else a very large trocar would have to be used with a quite small catheter. A No. 22 Foley catheter fits snugly in our trocar, and its introduction is a non-shocking, simple operation after which gradual decompression may be carried on if necessary.





# COLLES' FRACTURE SPLINT\*

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THE simple and inexpensive Colles' fracture splint described below has been used by the author in several adult size and the children size. These splints are made from  $\frac{1}{4}$  inch white pine wood. The distal end is cut

FIG. 1.



FIG. 2.

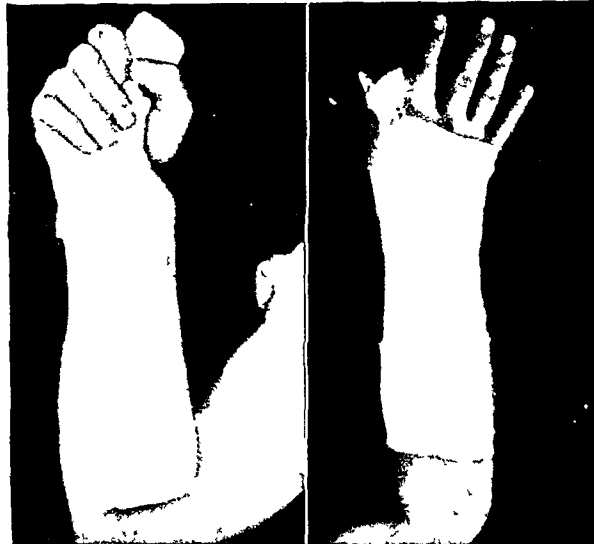


FIG. 3.

FIG. 4.

FIG. 1. White pine board splint produced at a cost of five cents each. One splint can be used for either the right or the left hand.

FIG. 2. Splint padded and adjusted to the forearm, after the reduction of the fracture.

FIG. 3. The distal end of the splint, being cut on the bias at an angle of  $45^\circ$ , favors and maintains ulnar deviation.

FIG. 4. Free use of the fingers is permitted and encouraged with this splint.

hundred cases with satisfaction. Each splint may be used either on the right or the left hand. There are two sizes, the adult size and the children size. These splints are made from  $\frac{1}{4}$  inch white pine wood. The distal end is cut on the bias at an angle of  $45^\circ$ . A carpenter can turn out a dozen at each operation and at a cost of only five cents per splint.

\* From the Allegheny General Hospital, Pittsburgh.

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# The American Journal of Surgery

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Fifty-third Year of Continuous Publication

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## Editorial

### MEDICAL ETHICS\*

BY medical ethics we mean the rules for conduct of the profession. There are certain fundamental rules of conduct which govern the acts of all men in their relation with others.

The first of these is invariably the golden rule, "Do unto others as you would have them do unto you." Under no circumstances should David Harem's rule, "Do unto others as they would do unto you, but do them first," be adopted.

The Prophet Micah admonished us to "Do justly, to love mercy, and to walk humbly." By *justice* we should mean to render unto others that which we would have rendered unto us. By *mercy* we should include gentleness in our dealings with the sick; generous in our devotion to duty; in every way consideration should be shown the sick or injured patients. *Humility* which we are enjoined to observe should guard us against the unhappy failing of egotism.

We should adopt as a motto: Be generous with others and critical of ourselves.

In 1847, at a Convention which resulted in the organization of the American Medical Association, a code of ethics was adopted. This code of ethics with very little change was the work of Thomas Percival, who first framed the code in 1792,

for the guidance of the Staff of the Manchester Infirmary (England). Chapter 1 of the Code states the object: "A profession has for the prime object the service it can render to humanity; reward or financial gain should be a subordinate consideration." . . . "In choosing this profession an individual assumes an obligation to conduct himself in accord with its ideals."

In discussing the subject of medical ethics or rules of conduct, one must remember that "Character is above intellect" (Emerson).

Our character is a compound of our heredity and our environment. For our heredity, we are grateful to our parents—especially to our mother—God's representative on earth, who guided and inspired our formative period with the noblest precepts and examples, one who dreamed of the day when her boy would take his place among men in the noblest of all professions—that of medicine.

She taught us gentleness, courtesy, respect for age and experience, consideration for others, a desire to share with others unselfishly, loyalty, devotion to duty, honesty in all contacts, and modesty. Armed with these teachings one comes to the age of discretion, with the sweet influence of home impressed upon him.

\* Lecture delivered at the Louisiana State University, November 15, 1943.

When one enters a professional school the medical environment begins to play a part in the formation of his character.

How well this factor helps to mold for the future the character of the boy will depend on the character of the teachers. The teacher should be a man whose ideals are above reproach, one whose ways are not tinged by selfish thought of personal aggrandizement; one who is not lead to do things which are purely spectacular, but whose work is performed with a singleness of purpose, intended to lead the younger aspirants to do things which are helpful to suffering humanity, and not done for the purpose of filling the purse or for newspaper notoriety. Purity of motives must actuate the teacher so that the pupil may have an ideal to follow.

The character of the doctor will manifest itself in his relations with his fellow practitioners. In considering the first of these, the relationship of the doctor to his patient in the community, the first rule of conduct should be the searching question: Am I prepared to assume the obligations which the opportunities granted me under the law to practice surgery require? If we acknowledge that the responsibility involved in any surgical procedure is one that places the life of the patient, so far as material help is concerned, in the hands of the doctor, he thus has within his grasp the awful responsibility for human life which cannot be recreated by the hand of man. It naturally follows then that one must continue through the years his preparation for his duties by continuous study, by contacts with his fellows through Medical Societies and by constant application of all available time to current literature.

I would like to repeat what I have said many times: The student days of the surgeon do not end with the diploma; they should conclude with the grave, and then the works of the good surgeon serves through the memory of his disciples as a stimulus so that the past lives in the future—an immortality truly to be sought.

We would do well to read the story of the life and works of Hippocrates, de Chauliac, and many other great leaders, whose writings have left an immortal imprint for us to follow.

Our approach to patients should combine sympathy, courtesy, and gentleness, particularly with the underprivileged. If you have an extra supply of gentleness and sympathy, share them with the poor and underprivileged. Remember that the well-to-do can select their doctors at will; the poor must accept those in positions of trust.

Confidential information which you obtain must not be divulged except with the patient's consent.

In your contacts with patients no matter what their status is, be sure to be tactful, dignified, and reserved when conducting a physical examination, particularly a female patient. Undue bodily exposure is to be deplored and avoided.

*Chapter 11 of the Code.* "The confidences concerning individuals, or domestic life entrusted by a patient to a physician, should be held as a trust and should never be revealed except when imperatively required by the laws of the State."

*Secrecy.* All records which you obtain must be kept as confidential. It is not only bad taste but definitely unethical to discuss with any one other than the patient or his family the ills of your patients. It is unfortunate that some of our profession make a habit of discussing with their friends the infirmities of patients. This unfortunate habit causes embarrassment to the patient and is detrimental to the good name of the doctor guilty of such practices.

From time to time you are going to be confronted with requests from Insurance Companies or from lawyers for information about patients. You are acting well within your legal and moral rights if you refuse to give anyone information, except on written consent and with the knowledge of your patient. You may be called in court to testify. I do not believe that you can

be forced to testify with reference to a patient's condition without his consent. If you are called to testify in court, testify directly, factually, and in language which can easily be understood by the court, and above all things avoid expressing an opinion, unless you are willing to qualify as an expert. If you do qualify as an expert, be certain that you are thoroughly prepared yourself in all phases and for all possible types of questioning which the opposing attorneys may hurl at you. It is easy for you to become the laughing stock in court unless you are adequately prepared.

*Chapter III.* Section I: "Requires the physician to comport himself as a gentleman and demands that he use every honorable means to uphold the dignity and honor of his vocation; to exalt its standards, and to extend its sphere of usefulness.

"A physician should keep himself pure in character and conform to a high standard of morals, and must be diligent and conscientious in his studies."

*Consultations.* Section II: "In serious illness, especially in doubtful or difficult conditions, then the physician should request consultations."

"In every consultation the benefits to be derived by the patient is of first importance. All physicians interested in the case should be frank and candid with the patient and his family. There never is occasion for insincerity, rivalry or envy and these should never be permitted between consultants.

"When an emergency occurs during the absence of the attending physician, a consultant may provide for the emergency and the subsequent care of the patient, until the arrival of the physician in charge, but should do no more than this without the consent of the physician in charge.

"When a physician has attended a case as a consultant, he should not become the attendant of the patient during that illness, except with the consent of the physician who was in charge at the time of the consultation."

*Misunderstandings to Be Avoided.* "The physician in his intercourse with a patient under the care of another physician, should observe the strictest caution and reserve; should give no disingenuous hint relative to the nature and treatment of the patient's disorder, nor should the course of conduct of the physician, directly or indirectly tend to diminish the trust reposed in the attending physician.

"A physician should avoid making social calls on those who are under the professional care of other physicians, without the knowledge and consent of the attendant.

"When a physician is requested to care for a patient during his absence, the patient should be returned to the care of the attending physician, as soon as possible."

No one can consider himself an expert in every field and should be ready to admit the necessity for a consultation. Do not be afraid of consultations with capable, competent, honest fellows within the profession.

If the progress of a patient under your care is not satisfactory, and there is a doubt in your mind, ask for a consultant. If there is a doubt in the mind of the family and they request a consultation, do not hesitate. When a consultation is to be had, try to have all the data possible, so that it can be given readily to your consultant, and be sure that you have left nothing undone, because if the consultant should ask in the presence of the family or the patient for one or two things which you have omitted, these very omissions cast a doubt on your activities and your worth in the minds of your patient and the family. All consultations should be for the benefit of the patient. Absolute honesty should mark the actions of the consultant. Avoid seeing patients as a consultant in the absence of the doctor in charge. You may be misquoted and the very misquoting of you may offend unnecessarily and unwittingly your fellow practitioner.

*Referring Patients to Other Doctors.* "When a patient is referred by one

physician to another for consultation or for treatment, whether the physician in charge accompanies the patient or not, It is unethical to give or receive a commission by whatever term it may be called or any guise or pretext whatever."

When referring a patient to another doctor, the reference should be made to one whom you think most competent to care for the patient. Referring a patient to another doctor should never be done with the idea of obtaining any part of the other doctor's fee for services which he may render. One of the most pernicious of all practices known to the profession, that of fee splitting, has developed out of mercenary motives on the part of some men.

In the Code of Ethics you will find the following:

"Giving and receiving of commission is condemned. It is derogatory to professional character for physicians to pay, or offer to pay commission to any person whatsoever."

"It is equally derogatory to personal character for physicians to solicit or receive such commissions."

"It is detrimental to the public good and degrading to the profession, and therefore, unprofessional to receive or give a commission."

"It is also unprofessional to divide a fee for medical advice for surgical treatment, unless the patient or his next friend is fully informed as to the terms of transaction."

*Fee Splitting.* Fee splitting or division of fees can be practiced in so many ways that it is difficult to do more than briefly outline some of the more evident methods.

I am sure that those who practice this underhanded, illegitimate method of dealing, know many more subterfuges than I can possibly outline:

1. Division of fees with a layman who acts as a barker for a doctor: This was the custom once in vogue in some of the resorts where the water was supposed to have certain healing properties. It was not

infrequently found that fellow travelers accosted people on the train to find out where they were going and in a perfectly innocent way, would say, "Well if you are going to such and such a place, and are in need of medical attention. I know Dr. So-and-So who is a good man." In this way many patients were directed to a particular doctor. It goes without saying that those who did the directing were on the train purposely and were being paid for their services.

2. Division of fees where the doctor obtains the fee for giving testimonials as to the efficiency of drugs or resorts.

3. Where the doctor obtains rebates from a surgical supply company for advocating trusses, corsets, and other mechanical devices which these surgical supply houses have for sale.

4. Where the oculist obtains a rebate from the optician who fills his prescriptions.

5. Division of fees with medical practitioners for referring patients. Referring patients to a surgeon, in return for which the surgeon gives the practitioner a fee.

6. Reciprocal reference of patients even though the other man is not well qualified, and one of the men realizes that the other is not qualified.

7. Rendering one fee bill when the patient does not know how much each doctor is to receive.

It should be accepted as a moral fact that one is obligated to let his patient know exactly what he is to receive from the patient, and what every one else connected with the case is to receive. There should not be any underhanded dealings by which any particular financial transaction connected with the individual's illness is concealed from the patient or his family.

When fee splitting first reared its head is not known to me. It is unlikely that division of fees or any other underhanded method of conduct within the profession should have existed prior to the days of "specialism." Highly competent methods bordering on purely commercial or mercenary procedures must have been the

result of the division of professional activities into the narrower group of specialists.

Overcrowding of the profession, mercenary types of medical colleges and the entrance into the profession of individuals whose training, both educational and familial, was not such as to develop the highest attributes of character so necessary for the appreciation of the standards set by Hippocrates and the long line of ethical leaders, who would have died rather than have the escutcheon of the profession carry a blot upon it, are responsible for this pernicious habit.

Fee splitting is a misdemeanor; it is disloyalty; it is treasonable and it is a conspiracy to defeat, not only the cause of justice, but of human rights. Some types may be said to be a misdemeanor. In the dictionary we find the definition of misdemeanor, "A fault or transgression, ill conduct, a crime of only moderate seriousness." The definition of disloyalty is "false to duty, government or friend." Treasonable is defined as "betrayal of faith, falseness to any trust or pledge."

Fee splitting is a betrayal of the confidence imposed on one by the school which trained him and which gave him a certificate or diploma. It is a betrayal of trust and a disloyalty, as well as a treasonable act to the medical societies which accepted him, after he had received his license to practice medicine. It is a betrayal of the trust that patients have in a man when they place in his hands the life and welfare of a member of their family.

Any secret dealing may well be called a dishonest act; if it were not so, then those

who enter into the secret pacts for personal gain would not make a secret of their pact.

Fee splitting is a prostitution in every way of the profession which should be the loftiest of all human professions; fee splitting is simply graft; fee splitting is obtaining money under false pretenses; fee splitting is the bartering of the human body by soulless beings for gold; it is a means utilized by unscrupulous doctors to obtain practice; it is an absolute prostitution of the medical profession.

The professional man owes obligations to his ancestors, his immediate family, the profession which recognizes him, and the public which trusts him. The name which one bears should be a sacred heritage to everyone of us. It is our duty to carry unsoiled the banner of our forefathers, thus showing the effect of our appreciation of training and family loyalty. No man wishes to bring disgrace upon parents or the children whom it is his privilege to guide.

No man should by any act bring disgrace upon the profession which has given him an opportunity to render service. No profession has nobler ideals than the medical profession. To carry these ideals into one's daily life is our duty. Public confidence in a group is often shaken by the acts of a few. Public confidence should not be shaken by the acts of any. To be true to the medical profession one's every act should be so performed that no reflection derogatory to the good name of his profession might result.

Let every one of us remember: "A good name is better than much gold."

ISIDORE COHN, M.D.



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# Original Articles

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## THE PLACE OF SURGERY IN FIBROIDS OF THE UTERUS\*

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FIBROIDS of the uterus have been known under other names since the time of Galen. During the drab and barren centuries that followed, three not unimportant observations became current: (1) Many of these tumors remained small, were symptomless or of slight symptoms and fortunately could well be left alone. (2) There were a considerable number of large, bleeding, degenerating and complicated tumors which furnished no small morbidity and mortality which it was difficult to check, and in which little could be done.

3. That many of these troublesome fibroids ceased to grow, receded in size, stopped bleeding and became decidedly less troublesome with the establishment of the fibroid menopause which was five, ten or fifteen years delayed. Oftentimes these looked for desirable results did not take place.

In 1872, Tait, one of the boldest and most prolific thinkers of his day, challenged by the hopelessness of observation No. 2 and stimulated by observation No. 3, undertook optional surgical castration to take the place of the delayed menopause. This was not ideal; it was not adequate. I cannot conceive that taking out normal ovaries and leaving a five, ten, fifteen or twenty pound tumor for the patient to struggle with as a foreign body appealed to the thoughtful and precise mind of Lawson Tait, but it was an opening wedge.

With repeated openings of the abdomen upon such pathological conditions, surgery

could not but advance in time to the removal of the diseased uterus. Hysterectomy with removal of the tubes and ovaries followed. Total hysterectomy and supra-vaginal hysterectomy became matters of earnest discussion. Vaginal and abdominal hysterectomies were compared. Gynecologic surgery became ovary conscious and ovaries were left for internal secretion. Myomectomy was performed that all of the genital functions might be saved even to child bearing. While myomectomy had its advocates, it was thought by some to have a greater morbidity and mortality than hysterectomy. Mayo presented a series of cases followed by twenty-eight deliveries in twenty-three cases with five more pregnant. He made a strong plea backed by these results for the worthwhileness of this measure in suitable cases during the child bearing period. The value of preserving menstruation was reflected in the operation of fundectomy or partial hysterectomy, permitting this function to go undisturbed. Surgery had largely displaced medication, waiting for the menopause and electricity. In the first decade of this century it had fairly well met the test. It was removing large complicated tumors and saving functions when possible.

Between 1905 and 1920 continental Europe was visited with a devastating epidemic of irradiation castration. Kelly in this country at a meeting in Washington held high the torch, a capsule of radium, that he emphatically and dramatically

\* Read before the Chicago Gynecological Society.

predicted would lead gynecology to the non-surgical treatment of fibroids. Many a man attended that meeting well content over the fibroid cases he had left at home and came away with an itching for 50 to 100 mg. of radium. Some procured 10, 15 or 25 mg. Some epigrammatist said fifteen cents worth of radium can do a million dollars worth of harm. We do not believe it. At the price then current the amount of radium would have been too small, but it shows the trend during those early years. Irradiation was supposed by some to have a selective action on the tumor, but it was found to be through the destruction of the ovaries that radium and x-ray influenced the fibroid. It was but a repetition of menopausal recession and the surgical castration of Tait of 1872.

But we were then a little too ovary conscious to accept generally this irradiation castration. Too much had been hoped for these radio-active substances to withdraw them, but we now entered a period of dividing the dose, hoping that it would kill the tumor and save the ovaries. Some enthusiasts claimed the ability to deliver just the dose that would produce a temporary sterility and predict just the time that ovulation and menstruation would return minus the evils of the tumor; but sometimes menstruation did not reappear and if so, the activity in the tumor returned. An urge was exhibited by some to have them effectual in not only small fibroids but in large degenerated and complicated fibroids.

Handley reported in 1913, that intensive doses of mesothorium destroyed all primordial follicles. Finch and others found the Graafian follicles extremely susceptible to irradiation. Matthews and others have shown that ovaries are more susceptible in mature animals than in young. Peck, McGreer, Kretzschmar and Brown, Burnam, Clark and Norris, and many others voice the opinion that there is no predictable ovarian conservation, and that if the ovaries survive the treatment, the tumor continues to grow. I think we have prob-

ably all seen young women treated with irradiation in which the promised return of menstruation never occurred, and in which a marked disappointment neurosis was present. These facts have led to limitations put upon irradiation during the menstrual age. Some have put the limiting age at thirty-five, some at forty, and some at forty-five. We are living in the age of recognition of the estrogenic function and I see no reason that this should be cut short ten years and the patient driven to the commercial laboratories if her own estrogenic laboratories can possibly be preserved.

The large tumor is reduced in size many times, but many times it is not. Burnam says 50 per cent of a series of cases were satisfactory. Kelly, reporting a series of large tumors, says a certain number reduced in size, but that no conclusions could be drawn as two years had not elapsed since the last treatment. So it seems that a patient must wait two years for an opinion as to the result of uncertain irradiation, when in the same class of cases surgery would remove the tumor and its complications in 100 per cent of cases.

A reference to the textbooks of 1915 to 1925 show a marked degree of confusion, an unwillingness to accept irradiation at its claimed value, and a reluctance to place it at its apparent value. During that time indications and limitations were urged which formulated would read as follows: A woman at the menopause, with a tumor which with the uterus makes a three to three and one-half months pregnancy size, slight to medium bleeding but with no other symptoms, degenerations, complications, associated conditions, malignancy and pregnancy definitely eliminated. This was approved by Clark, Graves, Lynch, Curtis, Danforth, Crossen, and others with slight variation, these referring mostly to a slight difference in size of the tumor and to age of limitations in which irradiation might be permitted. This was unequivocally supported by the sixty gynecologists answering the questionnaire. Some



included cases not good surgical risks, although W. J. Mayo was inclined to minimize this, having seen no cases that could not be gotten in condition for surgery.

In a thirty-two year experience in Cook County Hospital's large clinic and a longer period in a private clinic I have encountered no such case. In a poor risk fibroid case the tumor and its complications are the sole cause or a marked contributing cause of the disability, and in either case its removal once accomplished will be a marked factor in improvement. There are many patients not in good condition for operation when first seen, but there are aids to improvement much more efficacious than irradiation. I wish to make the point which seems very important that a patient, loaded with contraindications for irradiation, such as a very large tumor, complications, degenerations, does not have those contraindications removed by being a poor risk. Practically every patient can be gotten in condition for a skillful operation if they have vitality to live long enough to reap any benefit that irradiation could finally bring them. In low vitality patients irradiation has its risks.

To paraphrase a popular expression, "Time marches on," we have reached the time in which as never before the preservation of the estrogenic function is counted very important. Laboratories are busy trying to produce a biologic or synthetic product that will substitute for the decline or loss of function of the patient's own estrogenic laboratories.

In the ages before Tait, treatment was almost nil. Tait's ovarian castration was crude. During the next half century surgery was perfecting the treatment and undertaking when possible to save function. Then irradiation repeated the castration evil tenfold. Careful observers have worked out a formula of limitation by which we need not repeat the evils of the previous castration experiences.

Clark and Norris give us the following

list of limitations: (1) Cases in which doubt exists as to accuracy of diagnosis; (2) the presence of intraperitoneal lesions other than the myomas which require surgical intervention; (3) rapid growth; (4) associated neoplasms such as fundal carcinoma or ovarian tumor; (5) pressure symptoms; (6) softening or degeneration of the tumor; (7) inflammatory lesions within the pelvis, especially the adnexa (other inflammations may be more important); (8) when the tumor and uterus is larger than a four months' pregnancy (too large); (9) submucous tumors, especially pedunculated; (10) young patients (limit not usually under forty-five); (11) marked anemia out of proportion to the symptoms and clinical findings; (12) obstructing tumors or malformations, and (13) radiophobia.

These are legitimate contraindications and if this is true, let me add that irradiation is contraindicated unless and until an adequate diagnosis can say that these contraindications do not exist, for a pus tube, a pregnancy, an ovarian tumor, an extra-uterine pregnancy irradiated without a diagnosis is just as bad a procedure as irradiation of such a condition with a diagnosis. Irradiation is not limited by surgery; it is limited by contraindications. It is not limited by what surgery can or cannot do. Its application is of such facility that it would easily displace surgery if it could do the work; but there are so many phases in which it should not be undertaken at all. It cannot remove even small tumors during the period before the menopause without ovarian castration. It is conceded for the small tumors at the menopause with no complications, not because surgery cannot do the work and do it well, but because of the greater ease to the patient of irradiation, and with all indications met it does not do much harm.

But after the menopause the ovarian castration has taken place, and irradiation has lost its leverage. In marked bleeding after the menopause there is usually a degeneration or malignancy causing the

bleeding; the one does not respond favorably to radium and it may do harm, and the other, cancer, is not helped by a fibroid tumor dose and so the harm of delay. In large tumors it fails in a considerable percentage of cases and if it fails in a considerable percentage of cases, as a therapeutic measure, it fails *in toto*; for surgery stands ready to remove them all and one to two years' irradiation is therefore contraindicated.

Then, too, large tumors and larger tumors have more degenerations, more complications, more pressure, more incarceration, more intra-abdominal associated growths in which, with any or all of these irradiation is decidedly contraindicated, while the larger the tumor and the more the complications the more surgery is indicated.

The method of treatment in large tumors should avoid making a living sarcophagus (Clark) for a dying tumor, or a dying sarcophagus for a living tumor.

Any given treatment is determined by what another treatment can or cannot do, having in mind the best interests of the patient. Before the menopause irradiation castrates and should not be employed. After the menopause the woman is already castrated and irradiation is ineffectual. All authorities agree that irradiation is uncertain in its effects upon the large tumors. In the degenerations, complications, associated conditions, pressures, incarcerations, etc., in which large tumors abound, irradiation fails flatly and may do much harm and is therefore contraindicated. Irradiation of large fibroids has one point in common with murder; it would be far more successful if it were not for the difficulty of the disposal of the "body."

Into this surgical field comes radiology. One radiologist heads his announcement "ad" by "X-ray Treatment of Fibroid." "Gauss, a well known gynecologist in Freiburg, has practically abandoned surgery in the treatment of fibroids." Again, a paper read in the Section of Radiology entitled, "Treatment of Fibroids of the

Uterus" reports over 1,700 patients treated with irradiation, 262 of which were from four month pregnancy size up to full term. The author cautions about doing anything less than castration. He does not heed the precautions in regard to irradiation of women in the menstrual age or women with inflamed adnexa and many other complications. The Secretary coming to me said, "I don't see why you are opposed to these things. Why the treatment of fibroids is the biggest thing in radiology today." According to all testimony this means that castration of women under the menopause is the biggest thing in radiology today because it is through castration that radiology does its work. These expressions must not go unchallenged.

The tendency to ignore these indications and contraindications led me to undertake to find out the present day thought of gynecologists and x-ray men. The following questionnaire was sent to sixty gynecologists in Chicago, New York, Pittsburgh, Milwaukee, Toronto, etc., and to ten radiologists. The radiologists did not reply. One gynecologist with a radiologic institute connection replied.

1. About what proportion of fibroids do you treat surgically?
2. About what proportion do you treat with x-ray?
3. What would you consider proper indication for x-ray treatment of fibroids of the uterus?
  1. Size: of Walnut..... Yes No  
 Orange..... Yes No  
 Grapefruit..... Yes No  
 Baby's head..... Yes No  
 Full term pregnancy... Yes No  
 Three times size of full term pregnancy..... Yes No
  2. Location in the uterus:
    - Intramural..... Yes No
    - Subserous..... Yes No
    - Submucous..... Yes No
  3. With pus tubes..... Yes No
  4. With beginning carcinoma... Yes No
  5. With pus cavity in fibroid... Yes No
  6. During child-bearing age.... Yes No
  7. With uterine fibroid polyp... Yes No

8. At menopause..... Yes No
9. Two to ten years after menopause..... Yes No
10. With pregnancy..... Yes No
11. With ovarian tumor..... Yes No
12. With marked anemia..... Yes No
13. With fatty degeneration of fibroid..... Yes No
14. With calcareous degeneration..... Yes No
15. With necrosis..... Yes No
16. With incarceration..... Yes No
17. With herniation..... Yes No
18. With pressure symptoms..... Yes No
19. With prolapse of uterus..... Yes No
20. With rapid enlargement..... Yes No

Signature\_\_\_\_\_

No names will be used but it seems rather important to check on a certain "X-Ray for Fibroid" advertisement which is being run, which implies that surgery for fibroids is obsolete.

Thanking you for your cooperation in this matter, I am

Very truly yours,  
CHANNING W. BARRETT, M.D.

I cannot go into a complete analysis, but it will be seen that they were given a chance to say what they did with fibroids in general, what they would do with tumors of different size. All but two stopped with the orange sized tumor for radiation; one would go as high as a grapefruit and one as large as a baby's head. There was a strong consensus of opinion that only the intramural fibroid should be treated by radiation, but as most fibroids are multiple, some may be intramural while some may be submucous contra-indicating radiation.

There was a uniformity of opinion that radiation should not be used during the age of menstrual life.

Nos. 3 to 20 list some very important questions which must be answered in almost every large tumor and in some small or medium sized ones.

With pus tubes universally "no."

With beginning carcinoma, with one exception "no."

With pus cavity in fibroid, "no."

During child-bearing age, overwhelmingly "no."

With uterine fibroid polyp, "no."

At menopause, mostly "yes."

Two to ten years after menopause, most, wisely, "no"; one, "yes."

With pregnancy, "no."

With marked anemia, mostly "no"; a few, "yes," as temporary measure.

With ovarian tumor, "no."

With fatty degeneration, "no."

With calcareous degeneration, "no."

With necrosis, "no."

With incarceration, "no."

With herniation, "no."

With pressure symptoms, "no."

With prolapse of uterus, "no."

With rapid enlargement, "no."

With a few radiation for fibroids was out of the question. Surgical treatment averaged close to 90 per cent; x-ray mostly from none to 10 per cent, three going higher. Some who used surgery in only about 75 per cent of cases, used radiation very little or none at all.

Dr. Heaney very sagely remarked, "The trouble is, we think we have ruled out these complications by examination and then at operation, we find them." If that is the experience of the gynecologist, what are the chances for the radiologist?

Dr. Danforth said, "Formerly we used to treat cases at the menopause with radiation, but in the last few years we treat cases of fibroid with displacement, prolapse, scarred cervix, degeneration, etc., by vaginal hysterectomy and our patients are much more comfortable." With both of the above opinions I fully agree.

These answers grouped reconstruct very definitely the contraindications to radium and x-ray therapy which have been accepted. They combat any idea that surgery has become or is becoming obsolete. In fact, they show that the specialty which has to deal most with fibroids is putting less and less weight upon radiation. We deprecate the sophistry of x-ray teaching which accepts or lays down contraindications and then in the presence of a tumor argues that a tumor of size and complica-

tions and difficult to diagnose can just as well take its chance with irradiation; because after all surgery does have a mortality and if irradiation fails after a long course of treatment and waiting, surgery can then have its inning. We deplore those tumor groups which are built around irradiation equipment, especially as our customs allow them to advertise their wares and aspirations.

At this day the so-called treatment of fibroids resolves itself into the treatment of fibroids and its associated conditions. In small tumors before the menopause the associated conditions are functioning pelvic organs which irradiation cannot save. In large tumors there are in addition to size, complications and associated conditions which irradiation cannot solve and may make much worse. Surgery can take these on successfully.

Not a few fibroids have complications which even though the tumor disappeared as claimed, would remain a surgical condition and perhaps logically a worse surgical condition, and many have degenerations that preclude their disappearance.

Surgery in hyperfunction or dysfunction of estrogenic production gives opportunity to combine myomectomy, fundectomy, or hysterectomy with removal of the least healthy looking ovary, much to the benefit oftentimes of excessive hormonal production.

Before the diagnosis, prognosis and treatment can be determined, many points must be considered:

1. Is there enlargement in the pelvis?
2. Is there ascites, fat, a displaced organ, or upper abdominal tumor?
- 2a. Is the enlargement, in the uterus or some condition outside of the uterus, or is there both?
3. Is the possible enlargement a pregnancy or a tumor, or might it be both?
4. If a pregnancy and tumor, are there disturbing symptoms?
- 4a. If there is pregnancy and a tumor, is the tumor a uterine tumor or adnexal?

5. Is the patient of child-bearing age or at the menopause?

6. If of child-bearing age, does the uterus have child-bearing possibilities, that is, can the tumor or tumors be removed and the uterus saved?

7. If the tumors are numerous, is fundectomy or/and preservation of menstruation feasible?

8. If the uterus must be removed, are the ovaries, or is one ovary or a part of an ovary savable, to keep up the important estrogenic function?

9. Are their active infections or complicating inflammatory masses?

10. As the tumor grows, are there pressure symptoms, are there bladder, bowel, kidney, ureteral or appendiceal disturbances?

11. Is the tumor large enough to offer disturbances of weight and deformity?

12. Is there pain in the legs and/or swelling due to pressure on the nerves and/or blood vessels?

13. Is there rapid enlargement and increased bleeding and cachexia, indicating degenerations, infections, hemorrhages, and circulatory disturbances?

14. Are there acute symptoms, indicating strangulation, rotation, or incarceration?

15. Are there evidences of disturbed kidney, liver, stomach, bowel, heart and/or lung function?

16. Pancreatic, spleen, thyroid and brain disturbances must be looked for in severe cases with large degenerated and complicated conditions.

17. Is the heart and circulatory system, the respiratory tract, the alimentary tract, the urinary and genital tract in as good working conditions as possible?

18. If they are not, how long a preparation will the patient need and the surgical necessity warrant? Is there an immediate emergency, such as torsion, internal hemorrhage, bowel obstruction, etc.?

These may not all go on paper, but the careful diagnosis, prognosis and treatment must not leave them out.

The diagnosis must not only say whether there is or is not a fibroid tumor, but whether there is some other condition simulating it, what associated conditions exist, what complications, what degenerations and what is the size, relations, and bearing the complication or uncomplicated tumor may have upon the prognosis and treatment. All of these conditions may not be diagnosed and surgery is needed to make a complete diagnosis and right the condition.

The prognosis must take into consideration not only the patient's chances to live, but frequently the question of whether there is or is not a child *in utero* that has a chance to live and be born, and of the nature of the birth. The prognosis should also consider the question of the woman's right to her womanhood, her child-bearing function, her menstrual function and her estrogenic function, or whether in the bid for freedom from the tumor and its complications, these functions can afford to be placed in the discard or whether the patient may have them saved.

I venture the following working program for fibroids of the uterus, knowing from the answers to this questionnaire that most gynecologists are in agreement up to date:

1. Most small fibroids at any time causing no symptoms may be kept under observation.

2. Small fibroids in the child-bearing period that show a tendency to grow even though causing no symptoms, may be removed by myomectomy to improve the patient's chances of keeping a useful uterus; especially is this emphasized if the fibroid is in the cervix. Such a fibroid close to the menopause may still be allowed to go untreated.

3. A small fibroid appearing at the cervix or in the uterine wall causing hemorrhage should be removed by myomectomy during the menstrual ages. At the menopause it may be irradiated if in the uterine wall, but not in the cervical canal.

4. Large or medium cervical polyps causing profuse symptoms, may be removed by myomectomy, but the uterus should not be removed at the same time as one is working in the presence of infection and risk would be taken unnecessarily.

5. Small submucous fibroids may be removed vaginally during the child-bearing age. Larger ones by vaginal hysterotomy if possible and still larger ones by abdominal hysterotomy.

6. Larger subserous, intramural, or intraligamentous tumors may be removed by abdominal myomectomy and the patient left child-bearing, without being obliged to resort to hysterectomy. But, if a hysterectomy is necessary, the ovaries or one ovary or a portion of ovary should be saved.

7. Multiple fibroids making saving of the uterus impossible may in favorable cases be treated by fundectomy during menstrual life with preservation of menstrual and ovarian function.

8. Tumors larger than three and one-half months' pregnancy size should be removed by hysterectomy at any age, with or without degenerations or complications, unless in the child-bearing age it is favorable for myomectomy.

9. Fibroids at or after the menopause, that begin to grow or bleed profusely, have either a degeneration or beginning malignancy and should be removed.

10. Large tumors are usually degenerated, complicated, adherent or/and causing symptoms of pressure and should be treated surgically.

11. Large to very large tumors, with possible pus tube complications, pressure on bladder, rectum, ovaries, ureters, kidneys, sigmoid, cecum, appendix, attached to bowels, omentum, transverse colon, gallbladder, with inflammatory massing of all or many structures, with anemia, kidney and heart insufficiency, must still be operated upon; but great care should be taken to have the patient in the best condition possible and in the hands of

the best available man, or surgery will be no better than radiation and radiation is worse than useless, but by following lines of cleavage, promptly, and without accident or delay, such a case may not be so difficult.

12. Fibroids with extra-uterine pregnancy, or twisted pedicle or bowel obstruction, or acute appendix or ovarian cyst with twisted pedicle or rupture, must be operated upon promptly in spite of an apparent desperate condition.

13. Fibroids with pregnancy should in practically all cases allow the pregnancy to continue if it will in spite of any apparent future impediment to delivery. As the uterus enlarges a given fibroid mass may draw out of the pelvis, leaving the pelvis clear for delivery.

14. A tumor with a twisted pedicle or causing severe annoyance during pregnancy may be removed by myomectomy, but this should not be undertaken lightly, as it may end up in hysterectomy or/and loss of the fetus.

15. In the case of a tumor occupying the pelvis at term, that is not readily drawn up at labor or that cannot be pushed up, cesarean section should be done before the patient is exhausted. A myomectomy or hysterectomy may follow.

It sometimes happens that a fibroid, bleeding or otherwise, presents in which the fibroid, the adnexa, the bowels, the omentum, the bladder and the lower abdominal wall furnish a large undifferentiated, infected and infiltrated mass, pelvis engorged and under tension, bowels distended and inactive, abdomen swollen, and increase in temperature and pulse rate are considerable. Such a patient should not be operated upon until all the acute symptoms have subsided, except in some condition of extreme urgency. Pelvic tension should subside, bowel distention should be relieved, so that pelvic contents can be individually recognized. The anemia should be combatted by transfusion. An orderly system of approach should be used. Several layers more or less complete are recognized,

adherent, but more or less amenable to cleavage.

1. The abdominal wall should be opened rather high in the incision without attack upon the viscera. The omentum and adhering viscera should be carefully separated from above downward.

2. The omentum is now freed from below upward.

3. The bladder and bowels may now form an adherent layer over the tumor and uterus. The bladder should be pushed off from backward to forward and the small intestines, sigmoid and cecum, including the appendix, should be worked off from before, backward. If these structures are looked upon in any way as a part of the tumor mass or adnexal mass and worked out from backward to the fore, they run great risk of being separated from their mesenteric attachments.

4. The fibroid and uterus are now uncovered. The adnexa may be worked out of the cul-de-sac from backward, upward and forward.

5. The tumor and uterus now stand exposed or ready to be lifted out of the pelvis and out of the abdomen when it is frequently as readily subject to the four point clamp of blood vessels as is the less complicated case. At times the impacted, adherent tubes and ovaries are more readily removed after the large tumor and uterus have been removed.

#### CONCLUSIONS

1. Fibroids are very common, may be very disabling, and the large and disabling ones were once small, and the small ones should be handled if possible so that they never become the large complicated disabling ones.

2. Fibroids while having a relation to sterility and abortion, still leave the patient with possibilities in many cases for child-bearing, menstruation and ovarian function and no treatment should lightly take these functions away.

3. The patient's own estrogenic laboratories should be preserved instead of

causing her to fall back upon a commercial product.

4. Castration by surgery or radiation should be a matter to weigh seriously even as a last unavoidable resort.

5. Radiation without castration is admittedly not feasible.

6. Conservative surgery is the treatment of choice in women of the menstrual, child-bearing, ovarian function age.

7. Radiation may be used in small tumors at the menopause that present no complications and the only symptom is slight or moderate bleeding. Many of these small fibroid cases have complications that would be better served by surgery.

8. Surgery is the only treatment that can diagnose all the conditions, deal with all the complications, remove all of the tumor and other accompanying tumors, pus tubes, extra-uterine pregnancy and what not, and leave all that ought to be left.

9. To leave a degenerating ten or twenty pound tumor for the abdomen to struggle with is no more rational than to leave a lithopedion of the same size, and makes of the patient's abdomen a sarcophagus in which the more or less dead tumor dwells. All that is or can be

claimed is that it may, or may not disappear, that it may or may not reduce in size, that it may or may not grow again, that it may or may not degenerate into a malignancy.

10. The gynecologist and the patient want more than "may or may not"; they want a certainty of removal of the large tumor with all its degenerating complications and pathological processes. The treatment of the gynecologist for the patient with a large fibroid tumor is surgical.

11. May I suggest that the consideration of all of the phases of fibroid tumors complicated and uncomplicated is a gynecologist's problem as the prostate is a urologist's problem, and not solved by the possession of 800,000 kilowatts of deep x-ray and a pound of radium.

12. The greatest argument in favor of radiation was the pioneer surgery of the time of Gauss and his followers. The more finished surgery of the present day leaves no room for the function-destroying radiation except with the indications stated.

13. The claim of ovarian conservation with radiation destruction of the tumor has not been verified, so that surgery must be depended upon.



# HYDROCELE

## ITS RELATIONSHIP TO HERNIA

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A PERUSAL of the standard text-books and recent literature on the subject of hydrocele makes it evident that the frequency of a hernial association is seldom mentioned. Those that do mention this association leave the impression that the occurrence is infrequent. On the contrary, our experience reveals that hydrocele and indirect inguinal hernia are frequently concomitant and should be considered in any treatment given.

This paper will deal primarily with the idiopathic types. A review of the subject will not be amiss.

A hydrocele may be defined as a collection of serous fluid about the testicle or spermatic cord, in the cavity of the tunica vaginalis. Normally, a few drops of fluid are present between the visceral and parietal layers of the tunica as a protection to the testis. Any amount above this is abnormal and considered a hydrocele.

The testis is a retroperitoneal abdominal organ before its descent into the scrotum. As it descends on the gubernaculum testis, it carries with it the anterior covering of the peritoneum, which becomes the visceral layer of the tunica vaginalis. As the testis passes through the internal ring and the inguinal canal, it pushes before it a pouch of parietal peritoneum which is called the processus funicularis and which becomes the parietal layer of the tunica vaginalis. The visceral layer of the tunica after covering the testis, passes over onto the epididymis, which it includes between its two leaves and is then reflected onto the parietal layer of the tunica. It thus happens that the posterior inner border of the testis, where it is apposed to the

epididymis, has no peritoneal covering. Failure of normal closure anywhere along this path will cause a hydrocele of which there are many varieties.

Hydroceles may be classified according to their anatomical location as follows:

1. *Hydroceles of the Testis*: A. Those of the tunica vaginalis, where the fluid is in a sac directly connected with the tunica vaginalis. Of these, there are four forms: (1) The ordinary type, distending the closed tunica vaginalis. (Fig. 1.) (2) The congenital type, where the sac of the tunica vaginalis communicates directly with the abdominal cavity, due to complete failure of the processus funicularis to close. (Fig. 2.) (3) The infantile type, in which the sac of the tunica vaginalis and a portion of the processus funicularis are filled with fluid, but no connection exists with the abdominal cavity, representing a partial failure of closure of the processus funicularis. (Fig. 3.) (4) The inguinal type, a hydrocele in relation to an undescended testis.

B. Encysted hydroceles of the testis, in which the fluid is in a sac distinct from the tunica vaginalis, as in encysted hydroceles of the epididymis when the fluid is contained between two layers of visceral tunica as it passes from the testis over into the epididymis, and encysted hydroceles of the testis, where fluid is between the tunica albuginea and the visceral layer of the tunica. These are rare types.

2. *Hydroceles of the cord* may be of the diffused type, a serous collection of the nature of edema in the cellular tissue of the cord, or of the encysted type, fluid in a distinct sac originating either from some unobliterated portion of the processus



funicularis, or from a cyst formed independently of this process, by dilatation of persistent tubules of the organ of Giralde.

#### 4. *Hydrocele of the sac of a hernia.*

Hydroceles may be considered according to their course as *acute* or *chronic*, and as

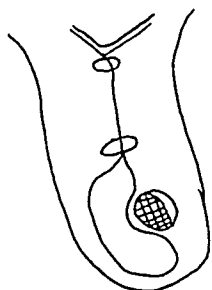


FIG. 1.

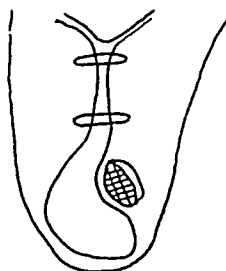


FIG. 2.

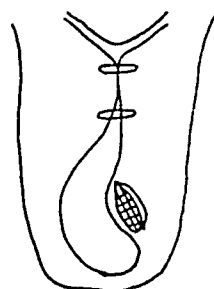


FIG. 3.

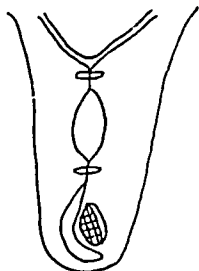


FIG. 4.

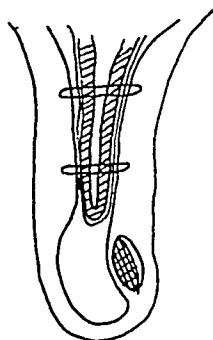


FIG. 5.

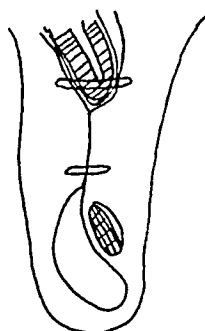


FIG. 6.

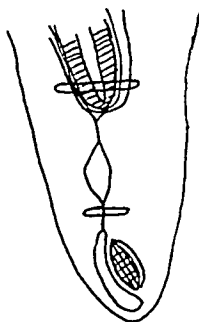


FIG. 7.

FIG. 1. Ordinary type hydrocele.

FIG. 2. Congenital hydrocele.

FIG. 3. Infantile hydrocele.

FIG. 4. Hydrocele of cord.

FIG. 5. Congenital hydrocele and hernia.

FIG. 6. Ordinary hydrocele complicated by hernia.

FIG. 7. Hydrocele of cord with hernia.

In women a collection of fluid in an unobliterated processus funicularis is termed hydrocele of the canal of Nuck. (Fig. 4.)

3. *Complications of these forms of hydrocele* represent any two forms co-existing or any form occurring with hernia. (Figs. 5, 6 and 7.)

to their origin as *symptomatic* or *idiopathic*. All the idiopathic are chronic, but not all symptomatic are acute.

Acute hydrocele may be caused by inflammation, infection or trauma to the testis and epididymis. These may become chronic when the fluid fails to be absorbed

after several weeks. Idiopathic or chronic hydroceles are the frequent result of an unknown mild, acute condition which fails to respond either because of persistence of the cause, or failure of absorption. Many men believe that tuberculosis is a frequent etiological factor, trauma another. There is a large group of those in which no cause can be found, and these are the types herein reported.

Symptoms most frequently complained of in this series of cases were: a dragging sensation, slight pains in the groin on exertion, interference with activity and the slow or rapid growth of the mass.

Diagnosis of the condition is by sight, palpation, illumination and the exclusion of the frequently found conditions as acute epididymitis, acute orchitis, hernia, spermatocele, hematocele, tumors of the scrotum, gumma, etc. A new method of x-ray study devised by Last in which an opaque medium is injected into the sac and films taken has been reported in the *Journal of Urology* for September, 1942.

Treatment can be limited to: (1) Palliative or tapping at frequent intervals; (2) injection after aspiration of fluid with a sclerosing fluid, and (3) surgical.

Tapping should be limited to children, in whom as occasional cure results. Tapping is also indicated in cases in which other measures are contraindicated. Aspiration and injection of sclerosing agents has had a wave of popularity in recent times as improvement in sclerosing material removed the objectional reactions such as necrosis, pain, allergic reactions and infection. These cases should be limited to simple uncomplicated hydroceles in which no communication with the abdominal cavity exists or in which there is an absence of infection of the hydrocele, scrotal contents, tumors and hernias. The ruling out of most of these is a simple matter, but it requires marked acumen to rule out the limits of the sac or even the presence of a hernia. The surgical approach is commonly scrotal. Various measures of dealing with the sac have been devised after exposure following scrotal incision.

It is with the treatment of the hydrocele in men between the ages of nineteen and thirty which we wish to report and show its frequent association with hernia. Commonly, these cases are treated surgically and very few men are cognizant of the frequency of this association and have, therefore, used the scrotal incision.

In a series of twenty cases in which the patients were treated surgically, seven were found to have a hernia either on physical examination or at operation. Prior to this report, a surgeon with whom one of us had the privilege of working, reported in conversations on the subject, this frequent finding. He induced us to make a study of the frequency of this association and this was done with the following results:

There were four cases of hydrocele of the cord, one associated with a hernia and undescended testicle, another with a hernia. Of the twenty cases, three were congenital hydroceles all associated with hernia, and one of these, with an undescended testis. The rest were of the ordinary type, two of which were associated with a hernia. All cases found with hernia had either gut or omental tissue in the sac, whether it was in the congenital hydrocele sac, or a separate pouch alongside the cord. All hernias without exception were of the indirect variety. This made the frequency of association 35 per cent. Of the twenty cases, only one hernial hydrocele and three uncomplicated hydroceles were on the left side.

Most were diagnosed at operation for frequently the hernia could not be discovered with certainty until then. Those communicating directly with the intestinal cavity could not be diagnosed on examination unless the hernia was fairly large.

From these findings, it is apparent that the frequency in the cases between the ages of nineteen and thirty of hernia and hydrocele are common, and should surgery be contemplated, an approach other than scrotal is indicated.

The usual inguinal approach for hernia is used in all the operative cases herein cited. Incision is made through skin, fat

and fascia. The aponeurosis of the external oblique muscle is left intact at this point. The cord is isolated below the external inguinal ring. An extension of the incision to the pubic spine or slightly beyond is very helpful. By pressure on the scrotum from below upward, all the scrotal contents can be readily invaginated into the wound and the sac and cord separated from the surrounding tissues with unusual ease. The patient is instructed to cough and a hernial sac, if present, can frequently be seen in the usual median site in those cases of the ordinary type. If there is no bulge, the hydrocele is opened and followed through its entire length. In the congenital variety, omentum or gut is found projecting into the hydrocele sac. If either of these are discovered, the aponeurosis is incised, exposing the entire inguinal canal and the usual means taken for the obliteration of a hernial sac. If no hernia is found, the aponeurosis remains intact. The incision and eversion method of Winkelman is used for the hydrocele. The testis is then replaced into the scrotal cavity, making sure complete hemostasis had been previously obtained. If a hernial repair has also been performed, the cord can now be treated by whichever method of herniorrhaphy desired by the surgeon. The wound is closed without drainage.

The after-care is very simple, in that it is not necessary to change dressing for five or six days, after which time all skin sutures are removed. Postoperative swelling of the scrotum is controlled by the use of ice-caps to the scrotum for the first twenty-four hours. A Bellevue bridge or suspensory is used for the first four days or longer. Only one case was complicated by infection and this was a superficial wound infection in which the skin and subcutaneous tissues became very firm, similar to the character described in a strumous thyroiditis. No cause for this condition could be found, and after a prolonged convalescence the patient was discharged cured.

The question arises as to how many similar cases with hydrocele repair performed by the scrotal route were followed by an inguinal hernial repair at a later date. Attempts to obtain this information from the record office of the Newark City Hospital were unsatisfactory, for the histories were too inconclusive to arrive at any definite opinion on this point. Again, the question arises. Couldn't the pull of the hydrocele or swelling at the inguinal rings make what would be called a potential hernia? By removing the weight and swelling, the musculature about the ring causes spontaneous obliteration of the hernia. This question also cannot be answered until further work with this in mind can be performed and results followed.

#### CONCLUSIONS

1. The frequency of hydrocele and hernial association in men between the ages of nineteen and thirty is approximately 35 per cent.
2. Hydroceles associated with hernia are more often located on the right side.
3. When resorting to treatment, consideration of the frequent association of hernia and hydrocele must be given.
4. The inguinal approach is indicated for the repair of hydrocele with the possibility of an associated hernia.

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# ABDOMINAL PREGNANCY

## SURVEY OF THE LITERATURE AND REPORT OF AN UNUSUAL CASE

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**A**LTHOUGH abdominal pregnancy is a relatively rare obstetrical condition, it presents many problems of interest. No general survey of the literature on this subject has appeared since that of Cornell and Lash in 1933. In this paper we propose to add twenty-two more well reported cases from the literature to the analysis of Cornell and Lash, bringing the total number up to 258, and to report a case of the rarest type of abdominal pregnancy—a full term, surviving infant without congenital anomalies or deformities and a surviving mother.

There are, in our opinion, five topics of interest in abdominal pregnancy: (1) Incidence, with regard to age, character of previous pregnancies, and time of diagnosis; (2) etiology; consideration of this leads into the fundamental problems of locus of fertilization of the ovum and mechanism of implantation; (3) methods of diagnosis; (4) optimal time of operative intervention, and (5) disposition of the placenta.

### INCIDENCE

The incidence of abdominal pregnancy is higher above the thirtieth year and yet

TABLE I  
AGE GROUPS

Years	Cases	Years	Cases
15-19	7	35-39	60
20-24	27	40 plus	18
25-29	55	55 (lithopedion)	1
30-34	54	64 (lithopedion)	1
		Not recorded	35

it is most frequent in the first and second pregnancies. (Tables I and II.)

TABLE II  
NO. OF PREGNANCIES

No. of Pregnancies	Cases	No. of Pregnancies	Cases
1	64	8	1
2	68	9	6
3	32	10	0
4	23	11	0
5	9	12	1
6	9	Not recorded	36
7	9		

These facts lend further support to the belief that the ideal childbearing period is before thirty years. The generally accepted observation of a high incidence of congenital abnormalities in fetuses of abdominal gestation is a corollary of the late appearance of this type of pregnancy in the childbearing period, although it is admittedly difficult to distinguish whether abnormalities are due to early defects in the ovum or to later pressure changes induced by the obviously abnormal gestation environment.

The data on previous pregnancies indicate that there is no way of predicting the likelihood of the occurrence of a

TABLE III  
CHARACTER OF PREVIOUS PREGNANCIES

Previous Pregnancies	Cases
Term only.....	91
Term and abortion.....	21
Abortion only.....	16
Term, abortion and ectopic.....	1
Term and ectopic.....	2
Ectopic only.....	2
Abortion and ectopic.....	1
Not reported as to type.....	77

subsequent abdominal pregnancy. (Table III.)

The data on race incidence are of no value because there would naturally be a higher incidence of reports on individuals of the white race.

About 80 per cent of patients reported had amenorrhea for six months or longer before the diagnosis was made. This probably indicates either: (1) the signs and symptoms of abdominal pregnancy are not insistent enough in the mind of the patient to cause her to seek medical advice before the latter months of pregnancy, or (2) the usual means of examination of a pregnant woman do not reveal this anomaly very readily before the last trimester.

It is of interest to state here that one patient with amenorrhea for twenty-eight months was operated upon in the fourteenth month for removal of the fetus and drainage was established without removal of the placenta. Menstruation and lactation did not begin until after a second operation for removal of placental remnants fourteen months later. Investigations on the duration of excretion of gonadotropic substance after delivery of near-term abdominal pregnancies with retained placenta have shown that anterior pituitary like substance may be expected to continue in good concentration in the urine for months following delivery. This observation correlates with the generally observed absence of engorgement of the mother's breasts and of lactation in such cases, supporting the generally accepted notion that the stimulus for lactation is a rapid drop in the blood level of placental hormones and the establishment of a new point of equilibrium in endocrine balance.

#### ETIOLOGY

From the available data it is difficult to decide that controversial question of the etiology of abdominal pregnancy and the actual occurrence of primary implantation of the fertilized ovum outside the genital tract. There are those who believe

that "abdominal" implantation is always a "transplant" from an ovarian or tubal position of primary implantation. There is certainly much evidence for frequent tubal ruptures and an abnormally high incidence of mild bleeding, especially during the early months of pregnancy. (Table IV.)

TABLE IV  
HISTORY OF BLEEDING

Type	Early	Late
Spotting.....	35	5
Continuous, mild.....	10	15
Irregular.....	17	22
Clots.....	0	5

The frequent observation that there is a generalized peritoneal reaction simulating a decidual reaction of the endometrium in ectopic pregnancies and recognition of the common occurrence of endometriosis certainly allow the possibility of so-called "primary abdominal pregnancy" but the number of such proved cases is very low. These questions of etiology cannot be settled with the present data and they richly deserve further study. Nevertheless, convenience of classification demands that the terms "abdominal pregnancy" and "primary abdominal pregnancy" have clear definitions. Survey of the literature leads us to suggest, for each, purely anatomical definitions.

"Abdominal pregnancy" describes any gestation which is not predominantly intra-uterine or intratubal in anatomical position, when discovered. Ovarian pregnancy should be a subdivision of abdominal pregnancy, because in well progressed gestations it is impossible to tell whether the pregnancy and implantation began in the ovary or involved the ovary at a later time.

"Primary abdominal pregnancy" describes any abdominal pregnancy in which evidences of origin from a primary intra-uterine or intratubal position are absent, and wherever the ovary is not definitely involved in the placental site. Concerning

the possible etiological relationship of salpingitis to abdominal pregnancy, there are not enough statistical data to warrant any conclusions.

### DIAGNOSIS

The diagnosis of abdominal pregnancy can be made on the basis of the following: (1) General history of impregnation, signs, symptoms and laboratory tests indicating pregnancy; (2) early signs and symptoms of tubal or other rupture phenomena with pain and bleeding; and later on in pregnancy, (3) failure of uterus to enlarge with enlarging abdominal mass which may be distinguished as separate from the uterus;

TABLE V  
PREOPERATIVE DIAGNOSES IN 181 ABDOMINAL PREGNANCIES

Diagnosis	No. of Cases
Abdominal pregnancy.....	83
Normal pregnancy.....	27
Pregnancy and fibroid tumor.....	16
Pregnancy and ovarian cyst.....	15
Placenta previa.....	6
Abortion.....	6
Pregnancy and acute appendicitis.....	5
Pregnancy and intestinal obstruction.....	4
Pregnancy and pelvic infection.....	3
Pregnancy and premature separation of the placenta.....	3
Pregnancy with transverse presentation.....	2
Pregnancy and toxemia with contracted pelvis..	1
Pregnancy and gallbladder disease.....	1
Pregnancy and peritonitis.....	1
Pregnancy and cervical obstruction.....	2
Pregnancy and proclivity.....	2
Pelvic tumor and peritonitis.....	1
Metritis.....	1
Ruptured uterus.....	1
Many diagnoses.....	1

(4) at abdominal examination, patient is usually sensitive to palpation; fetus readily felt, close to surface; fetal heart may sound unusually loud; no uterine contractions can be elicited; (5) at vaginal examination, the cervix is usually high and in abnormal position or pushed unusually low in the vagina; corpus felt sometimes as body separate from gestation sac, as previously mentioned; (6) transverse position of fetus is unusually common; (7) lipiodol visualization of uterine cavity may be used to confirm the diagnosis; (8) routine x-ray

examination may give rise to suspicion of abdominal pregnancy by extension or strange position of fetal extremities; (9) true labor fails to take place at term; and (10) the use of pituitrin in differentiation from full-term intrauterine pregnancy is used by some but is, we believe, contraindicated.

The essential information concerning differential diagnosis may be obtained from examination of Table v.

Abdominal pregnancy is seldom complicated by other diseases or tumors, including the toxemias of pregnancy.

### OPTIMAL TIME OF OPERATIVE INTERVENTION

Fetal mortality was very much higher in the eight to nine-month period of pregnancy than in the six to seven-month period, although infant mortality was naturally higher in the six to seven-month period. It is, therefore, concluded that a woman should not be encouraged to go to full term to secure a surviving baby from an abdominal pregnancy. There are not enough data to determine whether or not an abdominal pregnancy should in the interests of the mother be terminated before the beginning of the ninth month, but it is certainly evident from a survey of the literature that in general there is no specific contraindication to allow the pregnancy to continue at least until the eighth month. The operative risk for the mother, especially in the presence of hypertension, albuminuria or heart disease, is probably greater during and after the eighth month than it is before.

Fetal deformities were very frequent and sometimes multiple but were mostly attributable to abnormal position and pressure defects and were in a large majority correctable by orthopedic treatment. One fetus had no mouth, anus, or eyes. One had "pyloric obstruction." Only twelve living infants were recorded as free from deformity.

According to most authorities of experience, the best time to operate is the thirty-

sixth week and this period may be awaited in the absence of complications if the patient is under constant observation; after the thirty-sixth week, operation is indicated as soon as the diagnosis is made, because rupture of the sac, separation of the placenta with hemorrhage, infection and death of the fetus all occur with markedly increasing frequency after this time.

Although some obstetricians have tried to deliver by rectal or vaginal route (through the cul-de-sac), laparotomy seems to be by far the best route at any time in the pregnancy.

DISPOSITION OF THE PLACENTA

There are so many variables of importance in the question as to how the placenta should be treated that each case, it seems, must be judged on its own merits, but with certain important facts in mind:

1. Avoidance of blood loss is one of the fundamental precepts of good surgery. Table VI shows that shock due to hemorrhage at operation is the principal cause of death of the mother. This was in most cases probably due to attempt at removal

TABLE VI  
MATERNAL MORTALITY IN FORTY-SIX (17.8 PER CENT)  
OF 258 ABDOMINAL PREGNANCIES

Cause	Cases	Cause	Cases
Shock due to hemorrhage at operation	24	Uncontrollable uterine hemorrhage.....	1
Shock (not due to hemorrhage alone)	5	Toxemia.....	1
Shock without delivery.....	1	Pyelonephritis....	1
Peritonitis.....	8	Unknown.....	3
Intestinal obstruction.....	1		

of a firmly attached placenta which had not undergone the normal degenerative changes which occur with normal parturition and which is more characteristic pathologically of placenta accreta than of the normally implanted placenta in uterine endometrium.

2. The whole or parts of the placenta

may be left in the abdominal cavity preferably without drainage or marsupialization with very little probability of infection or hemorrhage, but constant observation of the patient for a more or less prolonged period is advisable to treat these emergencies should they arise. The mortality following different managements of the placenta is given in Table VII.

TABLE VII  
MATERNAL MORTALITY FOLLOWING DIFFERENT  
MANAGEMENTS OF THE PLACENTA

Procedure	Cases	No. of Deaths
Placenta removed entirely.....	162	17
Placenta removed partially....	11	2
Placenta left entirely.....	48	10
Not reported.....	37	

3. Forceful attempts at removing the placenta are said to result frequently in uncontrollable hemorrhage. It is obvious, however, that the maternal death rate was lowest in those cases in which the placenta could be removed *in toto* and in which drainage or marsupialization was not employed (Mason, 1940). Removal of the placenta at the time of delivery is definitely contraindicated in most cases when it is implanted on a vital organ, such as small intestines, stomach, liver or spleen. The problem of determining the best policy in cases in which it can be definitely established that the fetus is dead at the time of diagnosis is difficult to decide on the meager statistical evidence. But, inasmuch as an inactive placenta can be readily separated without hemorrhage, it may be advisable in the absence of complications and especially in early cases to wait a few weeks before laparotomy.

CASE REPORT\*

The patient, K. B., aged thirty-six, born in Greece, was admitted to the Lowell General Hospital with a diagnosis of abnormal pregnancy, on November 26, 1921.

\* Case of Dr. Thomas Forsley referred to Dr. Archibald R. Gardner.

Her father and mother were both dead of causes undetermined. There was no history of tuberculosis, diabetes, cancer, or insanity in the family. The patient also denied the presence of venereal disease in the family. She had always been well except for occasional coryza, "influenza" one and one-half years before admission, "rheumatism" the winter before admission; there was no history of hemoptysis, hematemesis, nausea, vomiting or anorexia. She had had some chronic constipation, but without other signs or symptoms of gastrointestinal disease. Catamenia had begun at the age of twelve years and periods were regular with normal flow and without pain. She had had four previous normal pregnancies by a previous marriage; the first child, a boy, died in Greece. Living children were a boy, twenty-one; girl, eighteen; boy, sixteen. She had been married to her present husband four years and had not had any pregnancies until the present one. The patient denied venereal infection.

She was first seen in July, at which time she complained of pains in the right inguinal region and back; she felt unusually tired and sick, with nausea, but without vomiting. She had mild constipation. The last menses occurred four months previously. She had passed a clot two months after the last menses and had had some leucorrheal discharge. The patient did not return again for examination until November 22nd, five days before operation; at this time she complained of pain throughout her abdomen, intermittent in character. She felt sick, fatigued and weak without nausea or vomiting. Her appetite was only fair and she complained of constipation.

Her general appearance was that of fatigue. Significant findings were limited to the abdomen, which was enlarged consistent with a full-term pregnancy. The fetus was in a transverse position, readily palpable, but the fetal heart sounds could not be heard. Vaginal examination revealed an undilated cervix which was not taken up, and it was not possible to palpate the fetus. There was no definite evidence of gonorrhea.

Operation was performed November 27th with the patient in the supine position. A median abdominal incision was made and laparotomy revealed membranes presenting and ruptured. Amniotic fluid and baby's buttocks presented into the incision; the cord

also presented. The infant was delivered and promptly cried vigorously. The uterus was palpated; it was normal in position and about the size of a closed hand. The placenta was attached to omentum, mesentery, right tube, right ovary (difficult to identify), and other structures in lower abdomen, except small intestines. The placenta was freed with ease and little bleeding from its sites of implantation, and thickened membranes were peeled off the opposing structures. The left tube and ovary were normal. The right tube was tied off. The omentum was brought down, separating the viscera from the incision site. Layer closure was carried out with catgut for peritoneum, chromic catgut for fasciae, interrupted stay sutures, and interrupted dermal stitches. The time for operation was thirty minutes. The mother's condition was good; she took gas-oxygen-ether anesthesia well, with slightly elevated pulse of good quality.

Laboratory data revealed that urinalysis was negative (four examinations) except for a slight trace of albumin on the day of operation. Red counts and white counts were within normal limits.

Postoperatively the patient was comfortable on December 3rd without fever. She experienced some pains from hemorrhoids. An erosion on the left breast was healing. The wound was cleaned and dressed and the baby nursed and was in good condition. On December 6th, the patient was comfortable and her condition good. The superficial dermal stitches were removed and the wound was clean. On December 9th the silk worm stitches were taken out and the patient's condition was good.

The infant at birth weighed 4 pounds, 15 ounces. It was male without anomalies or deformities. At discharge (December 12th) it weighed 4 pounds and was in rather poor condition. On December 9th a pustule on the back at the point of injection of glucose solution broke spontaneously; it was dressed with boric acid solution. Culture showed staphylococcus.

The infant gained weight and was normal and robust until death of an acute pneumonia at the age of four and one-half months. The mother died two years subsequently of metastasizing carcinoma of the breast.

#### SUMMARY

Abdominal pregnancy has been reviewed on the basis of an analysis of 236 cases by



Cornell and Lash and twenty-two more cases from the literature from the points of view of its incidence, etiology, methods of diagnosis, optimal time of operative intervention, and disposition of the placenta; and an unusual case, hitherto unreported, has been presented.

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*Correction:* Lt. Col. Harry M. Kirschbaum wishes to call attention to an oversight of his which occurred in his article, "Some Uses for Heavy Anesthetic Oils," published in our July 1944 issue. On page 93, in the paragraph beginning, "In some of the back injuries . . ." the sentence reading "This method could also be used in anesthesia during labor instead of the continuous spinal administration of novocaine" should have stated "continuous *caudal* administration of novocaine" (and *not spinal*).

# MESENTERIC VASCULAR OCCLUSION\*

## A PRESENTATION OF FIFTEEN CASES

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SINCE 1895, when Eliot reported the first successful resection of the small intestine for mesenteric thrombosis, each year witnesses several reports of cases on this subject. The reason may be that this entity is infrequently encountered by the average surgeon, or else the pathological process revealed at operation is so dramatic that it leaves an everlasting impression on the surgeon's mind. Especially is this true where resection produces an operative cure.

This disease is quite unusual because of its comparatively low incidence. A study of the literature on mesenteric occlusion reveals that the number of cases cannot be tabulated exactly. Many authors have attempted to calculate the number of cases in the past. A review of the literature presents the following figures: (Table I).

CHART I

Author	Year	No. of Cases Re-reported	No. of New Cases	Reported Successful Resections
Tiedemann	1843	20	1	
Virchow	1847		1	
Virchow	1854		2	
Litten	1875			
Eliot	1895		1	1
Gordon	1898			1
Tyson	1901-02	1 (5 yr old girl)		1
Taylor	1901			
Jackson, Porter and Quinby	1904	214		
Trotter	1913	359	7	24 (Review of literature)
Klein	1921			
Cokkinis	1926		76	
Jerrauld	1929			1
Whittaker and Pemberton	1938		60	
Fallis	1940			2
Moore	1941		8	
Giamarino and Jaffre	1942			1
Laufman and Scheinberg	1942		44 (6 were portal occlusion)	4

Trotter's survey has been taken as a basis for our own addition. To date it appears that about 554 cases have been reported of which thirty-two patients were resected successfully.

In our own experience at Kings County Hospital, Brooklyn, we encountered five cases during our surgical service. Further investigation revealed ten cases, diagnosed at necropsy or at operation, to have been recorded at Kings County Hospital from January, 1935, to December, 1943. To the number of cases previously reported we wish to add fifteen new cases. Of this number three operative survivals are recorded. This will bring the total number of cases following successful resection to thirty-five.

In our study of fifteen cases, ten of these will be presented in composite form. The remaining five, which came under our personal observation, will be presented in detail. (Table II.)

### CASE REPORTS

CASE 1. This is the story of a seventy-five year old white housewife who entered Kings County Hospital on October 6, 1942, and died on October 8, 1942.

At the time of her admission, her son gave us the history of her present illness. For the past two and a half days the patient had no bowel movement. She had had cramp-like abdominal pains associated with occasional bouts of vomiting for the same period of time. Cathartics and enemas produced no relief. During the past twenty-four hours vomiting had become more frequent and abdominal distention had been noted. Vomitus had never been feculent.

The past history is one of heart disease for many years which had responded to digitalis

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CHART II

Case	Age	Sex	Major Complaint	Tenderness, Rigidity, Distention	Clinical Heart Disease or EKG	White Blood Count	Bloody Stool	X-Ray	Operative Findings	Autopsy	Final Outcome
1	85	F	Shock	T + RLQ	EKG showed sinus tachycardia, ventricular extrasystoles, and severe myocardial damage.	.....	None	None	.....	1. Superior mesenteric artery thrombosis due to arteriosclerosis with gangrene of small bowel. 2. Infarction of lung.	Died 9 days after admission.
2	62	F	4 day history severe cramp-like abdominal pain. Vomiting and obstipation.	Shock T + + + General R + + + D + +	None	13,000, 84 % polys.	None	None	.....	Superior mesenteric artery thrombosis due to arteriosclerosis.	Died 2 hrs. after admission.
3	64	F	2 day history abdominal pain, vomiting constipation.	T + + + LUQ R + + + LUQ D <sub>0</sub>	None	Rose from 4,500 with 67 % P to 7,100 with 72 % P in 12 hrs.	None	Non-revealing	.....	Superior mesenteric artery thrombosis due to arteriosclerosis.	Died 3 days after admission.
4	50	M	2 day history abdominal pain and vomiting.	Shock T + + + General R + + + General D <sub>0</sub>	None	14,150, 62 % polys.	Present +	None	.....	Superior mesenteric artery thrombosis due to arteriosclerosis with general peritonitis.	Died 12 hrs. after admission.
5	48	F	2 day history abdominal pain and vomiting.	T + + + General R + + + RUQ D <sub>0</sub> Mass felt in RUQ	None	15,600 92 % P rose to 18,000 with 95 % polys in 4 hrs.	None	Partial intestinal obstruction	Superior mesenteric artery thrombosis with gangrene of small bowel.	.....	Patient operated upon 4 hrs. after admission. Died 6 hrs. postoperatively.
6	61	F	3 days of abdominal cramps, vomiting and bloody diarrhea.	Shock T + + + + General R + + + + General D <sub>0</sub>	Premature extrasystoles.	17,250 with 85 % polys.	Bloody diarrhea	None	Thrombosis of superior mesenteric artery and vein.	.....	Died 10 hrs. after admission.
7	47	M	24 hrs. of abdominal pain.	Shock T + + + General R + + + General D + + +	Gallop Rhythm EKG: left branch block, left ventricular strain, premature ventricular beat, Myocardial damage.	19,200 with 64 % polys.	None	Cardiac enlargement	.....	3 thrombi in intestinal branches of superior mesenteric artery with gangrene of small bowel. Thrombosis of right femoral artery. Old myocardial infarct. (autopsy finding)	Died 5 days after admission.
8	70	F	3 day history of abdominal cramp-like pain.	T + + + + General R <sub>0</sub> + + + + D + + + +	Auricular fibrillation.	19,800 with 92 % polys.	None	Small bowel obstruction	Superior mesenteric artery thrombosis with gangrene of small bowel.	.....	Died 3 days post-operatively.
9	66	M	2 day history of abdominal pain.	Shock D + + + +	Irregular rhythm.	?	?	None taken	.....	Thrombosis of superior mesenteric vein with gangrene of small bowel.	Died 24 hrs. after admission.
10	60	M	9 hr. history of cramp-like abdominal pain and vomiting.	To R + + + General	EKG showed left ventricular strain, sinus tachycardia and myocardial damage.	19,000 with 80 % polys.	None	Non-revealing	Superior mesenteric artery thrombosis with gangrene of small bowel. Bowel exteriorized at operation.	.....	Died 3 days post-operatively.

T = Tenderness

R = Rigidity

D = Distention

RLQ = Right lower quadrant

LUQ = Left upper quadrant

EKG = Electrocardiogram

under the observation of her family physician. She had had an inguinal hernia for many years which had been treated by means of a truss.

Physical examination on admission demonstrated an elderly, white, emaciated female with a florid face. She was in acute abdominal distress. Her temperature was 99°F., pulse 110 very irregular, respirations 24, and the blood pressure was 160/90.

The significant physical findings were: irregularity of pupils due to an iridectomy, dehydration of the tongue and pharyngeal congested. Cardiac examination showed a displaced PMI downward and to the left. Auricular fibrillation was present. Many moist râles were heard scattered throughout both lung fields posteriorly.

Abdominal findings were moderate distention with slight generalized tenderness, no peristalsis was audible, and no rigidity and no rebound tenderness elicited. A mass measuring 4 cm. by 2 cm. was palpated in the right inguinal region. This mass was moderately tender and not reducible; no impulse was felt on coughing. Rectal examination demonstrated external hemorrhoids; no blood was found on the examining finger. There was one plus pitting edema of both lower extremities.

The admitting diagnosis was intestinal obstruction due to an incarcerated inguinal hernia. Arteriosclerotic and hypertensive cardiovascular disease with auricular fibrillation and an enlarged heart, class IIB, was an additional diagnosis.

Laboratory data were as follows: Urinalysis: albumin 2 plus; red and white blood cells, 2 (high power field); red blood count, 3,900,000; hemoglobin 75 per cent; white blood count, 10,400 with 82 per cent polymorphonucleus; blood sugar, 123 mg. per cent; Wassermann test negative.

The electrocardiogram showed auricular fibrillation and myocardial damage.

X-ray studies showed evidence of partial obstruction to the lower end of the descending colon. The sigmoid was redundant upon itself and obscured detail; however, there may have been a constricting lesion in the lower end of the descending colon. A barium enema was advised and taken. It did not reveal any obstructing lesion of the colon or rectosigmoid.

The patient died thirty-six hours after admission. During this time she was given the conservative treatment for intestinal obstruction. Autopsy studies established the diagnosis to be:

(1) Thrombosis of the superior mesenteric artery due to arteriosclerosis producing gangrene of the small intestine, cecum and part of the ascending colon. The superior mesenteric artery was traced throughout its course. About two inches distal to the aorta, at the base of the mesentery of the small intestine, a large thrombus was encountered. This thrombus measured 3 inches in length and completely occluded the artery. (2) Other anatomical findings were compatible with congestive heart failure on a combined hypertensive and arteriosclerotic heart disease basis.

CASE II. M. F. a thirty-nine year old colored male entered the hospital on February 2, 1943, and was discharged on April 9, 1943.

He entered the hospital for a complaint not associated with his eventual difficulty. At the time of admission he complained of a swelling on the right buttock of seven days' duration. Seven days before admission he fell on a curbstone striking his buttock. Since then he had had progressive swelling in that region associated with pain. In 1937, he was struck in the same region with a baseball bat. Subsequently, a swelling occurred which was aspirated and blood withdrawn. It again became swollen, requiring wide incision and drainage.

He entered Kings County Hospital in July, 1942, for painful swelling and inflammation of the left groin. This was an inguinal abscess which was treated successfully. He is a known luetic under active treatment. He had a Neisserian infection in 1939.

On admission his pulse was 86, respirations 20, temperature 99.2°F., blood pressure 120/75.

The only findings of interest at this time were many soft cystic nodules over the entire body surface. They varied in size from 1 cm. to 5 cm. in diameter. They were more numerous on the chest, scalp and back.

Heart examination revealed no thrills,  $A_2$  was greater than  $P_2$ .

Systolic mitral and aortic murmurs were heard. The mass on the buttock was diagnosed as a cystic hematoma, the multiple masses were thought to be lipomas.

The hematoma was incised and drained, 800 cc. of dark sanguineous fluid being removed.

On March 9th, the patient had a sudden onset of cramp-like abdominal pain. Vomiting and tenesmus were noted. The abdomen at this time was soft and not tender to palpation.

Laboratory studies were: White blood count 28,000 with 90 per cent polymorphonuclears;

hemoglobin, 15 Gm., clotting time  $5\frac{3}{4}$  minutes (Lee and White); urinalysis was non-revealing; Wassermann test was negative; blood urea was 24, sugar 79.

A preoperative note on March 9th stated: In view of the soft distention, high blood count, and the absence of definite obstructive symptoms, the possibility of a mesenteric occlusion is entertained. A laparotomy was advised after preoperative blood transfusion and intravenous fluids.

Twelve hours after the onset of abdominal distress an exploratory laparotomy was performed. An x-ray taken before operation showed considerable small bowel distention consistent with a mechanical obstruction.

Operation revealed about 1,000 cc. of bloody fluid in the peritoneal cavity. A gangrenous ileum due to mesenteric thrombosis of a branch of the ileocolic artery was found. It was necessary to resect fifty-one inches of ileum commencing 2 feet from the ileocecal valve. An end-to-end anastomosis was performed.

Postoperatively, the only difficulty was marked diarrhea which was controlled by diet and medication. He was discharged on the thirtieth postoperative day.

CASE III. This patient was a fifty-six year old white rabbi who was admitted to Kings County Hospital on April 11, 1943, and discharged on May 23, 1943.

His chief complaint on admission was the sudden onset of acute abdominal pain of eight hours' duration. The pain occurred at 2 A.M. awakening him from his sleep. Shortly thereafter the pain became generalized throughout the entire abdomen. He vomited twice before entering the hospital. No description of the vomitus was obtained. His last bowel movement occurred two days before admission. There was a history of chronic constipation. No history of gastric distress was elicited.

At the time of examination his temperature was  $98.8^{\circ}\text{F.}$ , pulse was 104, respirations 20, blood pressure 110/90. The patient was lying in bed in no apparent abdominal distress. Examination of the heart and lungs demonstrated no unusual findings. Abdominal examination showed moderate generalized rigidity. Tenderness was elicited on deep epigastric palpation, but no tenderness in either lower quadrants and no rebound tenderness were present. Rectal examination revealed a slightly enlarged prostate. No blood was found on the examining finger.

Admitting diagnosis was acute surgical condition of the abdomen due to a perforated peptic ulcer.

Laboratory data were as follows: Urinalysis: no pathological findings; white blood count 11,000 with 81 per cent polymorphonuclears; red blood count 4,400,000; hemoglobin 88 per cent; blood chemistry: urea 43, creatinine 1.39, sugar 133; blood chlorides 492 mg. per cent. An electrocardiogram showed a sinus tachycardia to be present. X-ray revealed no free air under the diaphragm.

Ten hours after the onset of his abdominal pain, the patient was operated upon under general anesthesia. The findings were 1,000 cc. of bloody fluid in the peritoneal cavity, a loop of jejunum about 46 inches long was found to be gangrenous. The gangrene commenced 3 feet from the ligament of Treitz. The mesentery of this bowel was edematous and hemorrhagic in appearance. The mesenteric arteries were sclerotic to palpation. A resection was done followed by an isoperistaltic side-to-side anastomosis.

The only postoperative complication was a wound infection. The patient was discharged forty-two days after his operation.

CASE IV. This patient was an eighteen year old white, single girl, who entered the hospital on July 6, 1943, and was discharged August 30, 1943.

Her chief complaint on admission was one of rectal bleeding and vomiting of eighteen hours' duration associated with abdominal cramps. The pain commenced in both right and left lower quadrants and radiated to the back. She described the pain as constant and sharp. Vomiting followed the onset of pain and persisted up to the time of admission to the hospital.

The only significant past history was an appendectomy in March, 1943.

Examination at this time revealed the patient to be a thin, pale, well developed, well nourished white girl in apparent acute distress. Her temperature was  $101^{\circ}\text{F.}$ , the pulse was 120 and respirations 18, blood pressure 110/70.

The only findings of importance were abdominal. The abdomen was scaphoid in the upper half, and distended in the lower half. A McBurney healed incision was noted. Diffuse tenderness was elicited in both right and left lower quadrants. Peristalsis was not audible. Rectal examination demonstrated blood on the examining finger.

The impression at this time was an acute intestinal obstruction with strangulation and gangrene of the small intestine.

Laboratory data were as follows: Urinalysis normal findings. white blood count 26,000 with 90 per cent polymorphonuclears; red blood count 5,800,000, hemoglobin 10 Gm., blood chemistry: urea 40, creatinine 1.25, sugar 84, blood chlorides 350.

Four hours after admission the patient was subjected to surgical intervention. The findings were 1,000 cc. serosanguineous fluid in the peritoneal cavity and gangrene of the ileum. The necrosis commenced five inches from the ileocecal valve and extended proximally for a distance of 4 feet. This was due to an occlusion of a branch of the ileocolic division of the superior mesenteric artery. The patient's pulse and blood pressure became imperceptible and it was decided to exteriorize the involved loop of ileum, which was subsequently removed.

A second operation sixteen days later was performed in which the intestinal continuity was re-established via an ileocolostomy.

Recovery was uneventful and the patient was discharged fifty-four days after her admission.

CASE V. On October 22, 1943, a fifty-nine year old white male entered the hospital and died on October 24, 1943.

At the time of admission he complained of pain in the left inguinal region. He informed us that he had had a swelling in his left inguinal region and testicle for three years (a hernia). For the past three or four months he had had occasional pains in this region. Since the day before admission the pain had become more severe and constant. No vomiting occurred at any time. On the morning of admission he passed some small, hard feces. He ate his usual breakfast. There was no history of weight loss, melena or gastrointestinal disturbances.

The only past history worthy of recount was an operation two years previously for hernia. For three years he had been treated for "heart trouble."

Physical examination presented the following salient features: The temperature was 98.6°F., the pulse 80, respirations 20, the blood pressure was 122/76.

Examination of the lungs showed many sibilant and sonorous râles to be present posteriorly.

Clinical heart studies revealed no abnormal findings. Abdominal examination at this time

demonstrated no unusual findings excepting a left scrotal hernia which was reduced by taxis.

Twelve hours after admission signs of an acute surgical condition of the abdomen developed. Rectal examination at this time showed many external hemorrhoids, an enlarged prostate (2+) and fresh blood was present on the examining finger.

Laboratory data (after acute signs developed) were as follows: white blood count, 21,000 with 88 per cent polymorphonuclears; red blood count 3,100,000; hemoglobin, 60 per cent; urine was normal. X-ray of the abdomen demonstrated no evidence of obstruction. A large ureteral calculus was visualized.

Thirty-six hours after the onset of his pain the patient was subjected to an exploratory laparotomy. The preoperative diagnosis was perforated ulcerating carcinoma of the colon or a gangrenous loop of small intestine following the incarceration.

At operation, 1,500 cc. of bloody peritoneal fluid was found. An ulcerating rectosigmoidal neoplasm was present associated with a thrombosis of the inferior mesenteric vein and subsequent gangrene of the descending colon and sigmoid. The gangrenous area was resected. The splenic flexure was employed as a colostomy, the viable distal end was dropped into the pelvis beneath the peritoneal reflexion. The patient was in shock. Sixteen hours after the operation he expired. (Fig. 1—Case v.)

#### ETIOLOGY AND PATHOGENESIS

Many investigators have attempted to explain mesenteric vascular occlusion and each has postulated his own concept of the pathogenesis. Most writers have divided their cases into the arterial and the venous type. Further subdivision was attempted as to whether the superior or inferior mesenteric vessels were involved.

In 1938, Whittaker and Pemberton studied sixty cases.<sup>28</sup> This series showed nineteen cases to be arterial occlusion, eighteen of which occurred in the superior mesenteric artery. Twenty-seven cases were venous occlusion; the superior mesenteric vein was incriminated in twenty-five cases. The remainder of the cases in this series were combined arterial and venous occlusion.

Contrary reports have been published. Trotter reveals that arterial occlusion contributed 60 per cent of his total cases with 40 per cent of cases due to thrombosis of the mesenteric veins.<sup>22</sup> Larson concurs in this statement and found arterial thrombosis more frequent than arterial embolism.<sup>14</sup>

More significant than the frequency of location of the disorder is the problem of the manner in which this disease occurs. Embolism of the superior mesenteric artery may occur in patients with heart disease. The embolus usually arises in the left side of the heart from vegetations on the valves or a thrombus in the auricle. Intestinal infarction results when the embolus lodges in a larger branch of the superior mesenteric artery.<sup>2</sup> When arterial thrombosis occurs, it may be traced to atheromatous degeneration of the vessel wall. The superior mesenteric artery is more frequently concerned, especially in embolism, than is the inferior mesenteric artery. The reason offered was its earlier exit from the aorta and because of its more direct continuation from the abdominal aorta.

Venous thrombosis of the mesenteric vessels is usually associated with infection in organs or viscera that are tributaries to the portal vein. The conditions usually antedating the thrombosis are appendicitis, inflammatory pelvic disease, or ulcerating colonic carcinoma. Primary venous thrombosis is quite rare. When it occurs it is due to endophlebitis or phlebosclerosis.<sup>2</sup> In secondary thrombosis when inflammatory lesions are not in evidence, injury to the vessel wall (as in constrictions from a strangulated hernia), should be remembered as an etiological factor.

The pathological condition resulting from vascular occlusion is infarction. The infarct is always of the red or hemorrhagic variety. It usually involves the lower part of the jejunum and the ileum. There have been occasional cases in which embolism or thrombosis of the main artery have resulted in hemorrhagic infarction extend-

ing from the lower part of the duodenum to the transverse colon.<sup>2</sup>

Macroscopic appearance of the involved



FIG. 1. Microphotograph of the ulcerating anaplastic adenocarcinoma of the rectosigmoid with secondary inflammatory changes as found in Case xv. (125 X) The neoplasm is believed to be the nidus for the venous thrombosis in this instance.

segment is a wall which is thickened, edematous, dark red in color rapidly becoming gangrenous. The entire lumen contains thick, semi-coagulated blood. The peritoneal cavity contains bloody fluid. Generalized peritonitis may be present.

Microscopically, the lumen of the bowel is filled with a large amount of hemorrhagic edema fluid. The mucosal lining shows all stages of degeneration ranging from edema to necrosis. The edema is seen in the submucosa. Vessels are often dilated and filled with large quantities of erythrocytes. The muscular layer and serosa show a hemorrhagic reaction. (Figs. 2 and 3—Case III.)

In the pathogenesis of this disease the question of collateral circulation arises. How is it that a circulation, which from an anatomical viewpoint has such ample anastomoses, acts as if it were a terminal artery?<sup>2</sup> Litten attempted to answer this question.<sup>16,17,18</sup> He postulated that the superior mesenteric artery, although not an end artery, acts like one. Sudden occlusion of the main artery experimentally, results first in violent spastic contractions of the entire small intestine from the ligament of Treitz to the middle of the



transverse colon. This reaction is interpreted as an anoxic response to the sudden cessation of arterial blood flow. This violent

known. Laufman believes that it may be one of reflex vasodilation or the result of an underlying predisposition to thrombosis.

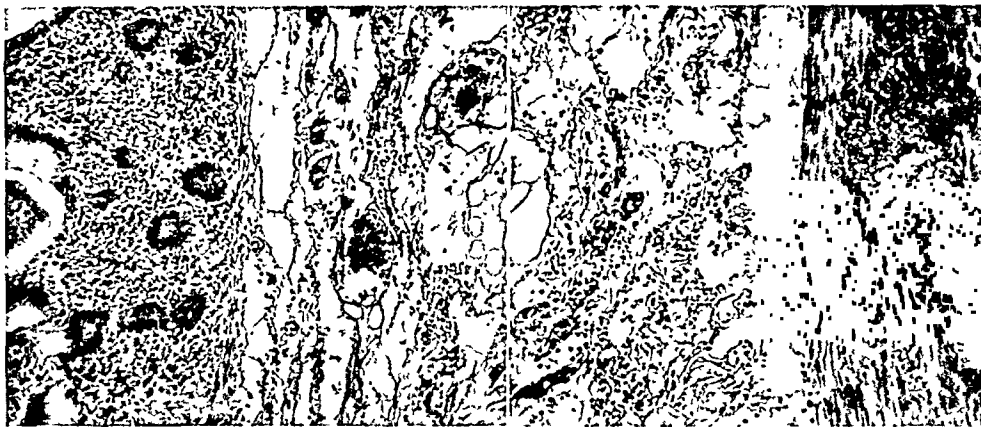


FIG. 2. Microphotograph illustrating the hemorrhagic infarction of the small intestine in Case XIII. Hemorrhage is noted in the mucosa and submucosa. (125 X.)

FIG. 3. Same section showing hemorrhage in the submucosa and the muscle layer. Disruption in the continuity of the muscle bundles is seen. (125 X.)

spasmodic contraction of the musculature isolates the segment from the neighboring circulation. The spasm aggravates the anemia to such a degree that death of the affected segment speedily results.<sup>2</sup>

The mechanism of hemorrhagic infarction following arterial occlusion has been a debatable topic since the era of Virchow. Welch and Mall found that the same result was obtained when both the artery and vein were ligated.<sup>27</sup> They concluded that the hemorrhagic infarction was due to a reflux of arterial blood which came by way of collateral channels. Another thought on this phase of our subject has been expressed, "As the musculature of the intestine relaxes the negative pressure created in both the arteries and the veins is sufficient to draw blood back into the wall of the intestine. Even if both the superior mesenteric artery and vein are ligated, there is enough blood left in the mesenteric system, to be siphoned back and result in hemorrhagic infarction."<sup>15</sup>

A possible etiological factor has been reported by Laufman and corroborated by Bauer in a case report.<sup>1,15</sup> They reported deaths due to mesenteric arterial occlusion following oblation of the lumbar sympathetic chain. The actual mechanism is not

As a general statement it may be stated that the predominating cause of mesenteric occlusion in younger patients is found to be heart disease or infection. In older patients the degenerative or malignant precursors appear to be important etiological agents.

#### COMMENT

Attempts have been made to outline a clinical symptom complex which might serve as a basis for the early diagnosis of mesenteric occlusion.<sup>3,10</sup> Some believe that venous mesenteric occlusion can be segregated clinically from the arterial type.<sup>3</sup> It is most difficult to diagnose mesenteric vascular occlusion preoperatively or ante-mortem. How much more difficult it is to differentiate the venous from the arterial type can be appreciated.

The former belief that cardiac disease, especially auricular fibrillation, is a prerequisite for superior mesenteric arterial occlusion has not been our experience. The erroneous concept that blood passed by rectum is almost always present<sup>2</sup> is not tenable. It is believed, however, that hematochezia will be present more often in inferior mesenteric occlusion than in superior mesenteric occlusion, especially when it is of the venous type.

Mesenteric vascular calamities are still found most often in the elderly. This is believed in spite of the case report of Taylor. He reports a vascular occlusion in a five year old girl.<sup>20</sup>

Two of our cases occurred in the younger adult group: one patient was an eighteen year old white girl, the other a thirty-nine year old negro.

What aids are available to the surgeon as guides to the diagnosis of mesenteric vascular occlusion? No pathognomonic sign or symptom is available. This pathological state should be considered, however, in all elderly patients who develop the picture of an acute surgical condition of the abdomen within a period of two or three days. Abdominal pain is almost always a constant complaint. This may be cramp-like, constant or intermittent. Vomiting is a later complaint which is almost always present. Bloody vomitus is rarely seen in these cases from our experience. Constipation or diarrhea were not dependable factors. Melena, or occult blood in the stools, was infrequently noted. Shock was a frequent major phase of the clinical picture. It was most often present in arterial occlusions.

Abdominal examination revealed three signs which were present most commonly. These were tenderness, rigidity and distention. Of the three tenderness, either generalized or localized, was most frequent. Tenderness with rigidity were next in frequency. Soft distention was usually an unfavorable prognostic sign. A point of note was the moderate degree of abdominal tenderness in the presence of apparent intense pain. Diminished auditory peristalsis was almost always present.

A rise in temperature is a late manifestation. The pulse tends to rise before the temperature. Blood pressure studies vacillate according to the presence or absence of shock and the degree of shock when it is present. The existence of hypertension before the onset of the abdominal catastrophe may alter the blood pressure values even in the presence of shock.

The white blood count is often valuable. Leucocytosis, often as high as 30,000, occurs when vascular embarrassment with incipient gangrene is present.

Consideration of a differential diagnosis suggests several other entities. These are acute intestinal obstruction, strangulation of the small intestine, acute pancreatitis, and perforated peptic ulcer.

In the study of our series of cases certain instructive lessons were learned. Case II presented a postoperative problem of intractable diarrhea. This gave rise to the question, how much small intestine may be removed without physiological distress. Our investigation of the literature brought to our attention the work of Flint.<sup>8</sup> His experiments on dogs permitted the removal of 50 per cent of the small intestine without untoward effects. He observed that the dogs had severe weight loss, and that they remained extremely sensitive to unfavorable conditions of diet. The most beneficial diet was found to be one of high carbohydrate and low fat. Protein is not utilized as fully as normally but in the presence of a diet rich in fat, dogs deprived of half or more of their small intestine exhibited a marked increase of nitrogen excretion in the feces.<sup>8</sup>

According to Flint, a compensatory process consisting of hypertrophy of the absorbing surface of the remaining intestine occurs after extensive resections. There is an increase in size of the villi and crypts amounting in some cases to 400 per cent increase in the absorptive area.<sup>8</sup>

The most extensive resection of small intestine recorded was performed by Jerrault.<sup>26</sup> He excised 19 feet of small intestine for gangrene caused by an embolus of the superior mesenteric artery. The patient was subsequently operated upon by Washburn for intestinal obstruction due to adhesions, at which time 10 feet of small intestine remained. The patient continued to have periods of diarrhea up until three years after his first operation.<sup>12</sup>

Our Case IV is most unusual from the point of view that the disease occurred in

an eighteen year old girl. As far as we could determine only one other case has been recorded in a younger person. Taylor's case in a five year old girl is the youngest on record.

The last case recorded illustrates how organic disease may be concealed beneath a hernia. On many occasions it has been our experience that a patient may have a hernia for many years and then suddenly develop pain in that region. Too frequently the hernia is indicted for this distress. In our Case (v) the patient believed his difficulty was due to the hernia which masked a hidden ulcerating neoplasm. This new growth nurtured an autochthonous thrombosis which produced an inferior mesenteric venous occlusion with gangrene of the descending and sigmoid colon.

It has been taught that obstruction of the inferior mesenteric vessels is not likely to produce gangrene because of the multiple arterial communications.<sup>2</sup> This case illustrates that such a statement is open to debate and that occlusion of the inferior mesenteric vessels can be as lethal as occlusion in the superior mesenteric group.

#### SUMMARY AND CONCLUSIONS

1. A literary review plus a résumé of the current thoughts on the pathogenesis of mesenteric vascular occlusion is presented.

2. A review of fifteen cases is made with three patients cured by intestinal resection. All are living and well at the time of this writing.

3. Our mortality rate is as high as that reported elsewhere. This mortality ranges from 60 to 90 per cent and is due to shock, loss of blood and fluids.

4. The appalling mortality associated with this disease can be lowered only by improvement in diagnosis.

5. No pathognomonic findings are known. Onset of an acute surgical condition of the abdomen in an elderly patient may suggest this disease. Clinical differentiation between arterial and venous occlusion is most difficult.

6. Shock is more pronounced than in

most other abdominal conditions with the exception of pancreatitis.

7. Pain is out of proportion to the physical findings.

8. Physical findings are usually variable degrees of tenderness, rigidity, distention and absence of peristalsis.

9. Previous fallacies were the need for cardiac irregularities and bloody stools in the clinical picture of this entity.

10. In our series, occlusions in the superior mesenteric vessels occurred more frequently than those in the inferior mesenteric vessels.

11. A brief discussion is made as to physiological imbalance in extensive resection of the small bowel.

12. Conservative therapy in cases of mesenteric occlusion is ineffectual treatment. Surgical intervention with radical resection of the involved loops (beyond the areas of edema) is the only hope for cure.

13. Treatment is of no avail in those cases in which occlusion of the superior mesenteric artery produces gangrene of the entire small intestine. Treatment is ineffectual in other cases in which the patients' general condition is so desperate (due to shock, heart disease, toxemia or liver damage) that any operative procedure cannot be contemplated.

In an article accepted for publication by the American Journal of Roentgenology and Radium Therapy, Dr. Richard A. Rendich and Dr. Leo A. Harrington of the X-ray Department of Kings County Hospital, Brooklyn, New York, described their x-ray observations in three proven cases of mesenteric thrombosis.

Briefly, in each of these cases a plain film of the abdomen disclosed distention of the small bowel and the proximal half of the colon down to the splenic flexure. This finding simulated a mechanical block near the splenic flexure. In one case a barium enema was administered but no mechanical obstruction was found.

The distention of the colon down to the splenic flexure corresponded to the distribution of the superior mesenteric vessels.

Although these are new concepts, the x-ray findings in these three cases suggest that the possible diagnosis of thrombosis of the superior

mesenteric vessels be among those considered when the plain film of the abdomen discloses bowel dilated down to the region of the splenic flexure, simulating a mechanical obstruction. If a subsequent barium enema reveals no obstruction, these writers believe that the diagnosis may be ventured with some probability.

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# INTRAVENOUS ANESTHESIA IN MAJOR SURGERY

## USE OF ONE PER CENT SOLUTION OF PENTOTHAL SODIUM

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A CRITICAL analysis of intravenous anesthesia with the short-acting barbiturates shows that this method represents an outstanding advance in anesthesiology on account of the following advantages:

1. Ease of induction, without the stage of excitement, greatly appreciated by the anesthetist and the patient as well.

2. Simplicity of administration, not requiring expensive or complicated apparatus. This applies only to minor operations in which no supplemental anesthesia is necessary.

3. Minimal effect upon the circulatory system, no significant changes being observed in the pulse rate, pulse volume, the blood pressure or electrocardiographic tracings.

4. No ill effects after and no objections of the patient to repeated employment of the same anesthetic.

5. Very few contraindications. To cite Parsons,<sup>1</sup> "impaired pulmonary ventilation and respiratory obstruction are contraindications. This type of anesthesia is, therefore, not indicated in sucking wounds of the chest, in lung conditions, in heart disease, in marked abdominal distention, in neck abscesses when artificial airways are used, and in cases in which mucus or fluids may accumulate in the pharynx." We may add that, as a rule, the drug should not be used in children less than ten years of age or in patients in marked shock caused by loss of blood, although some surgeons employ pentothal sodium successfully in patients with shock.

6. Freedom from nausea and vomiting, which pleases the patient and allows an early administration of fluids by mouth.

7. Satisfactory relaxation, in many

instances superior to that obtained with inhalation anesthesia.

8. Restriction of amplitude of respiratory movements, especially welcome in surgery of the upper abdomen.

9. Rarity of postoperative complications such as pulmonary atelectasis or pneumonia.

10. Absence of danger of explosion, permitting safe utilization of electrocoagulation.

11. Replacement of blood losses by saline solution in which the drug is dissolved. A Y-connection allows a simultaneous transfusion of blood or plasma.

Only three factors offset the aforementioned merits of pentothal sodium intravenous anesthesia: depressing action on respiration, danger of phlebitis and variations in individual tolerance. None of them is of great practical significance as these factors can usually be avoided with proper technic.

Pentothal sodium firmly established its place among anesthetics and the publication of this paper is, therefore, justified only because it describes two modifications of the customary technic, which gave highly satisfactory results in a relatively large number of cases, namely, the continuous drip and the use of a 1 per cent solution.

On account of variations in individual tolerance, the originally recommended injection of one calculated single dose was replaced by the intermittent mode of administration of fractional doses of a 5 per cent or 2½ per cent solution. However, three disadvantages of the intermittent method may be pointed out: First, clogging of the needle may occur since the solution is not flowing continuously. To overcome

this possibility, glucose or saline solution may be administered through a Y-connection which makes the set-up a little more complicated. Second, the intermittent mode of intravenous administration of an anesthetic may be compared with driving a car by stepping on the accelerator from time to time, instead of exerting a steady pressure on it. It is obvious that it is more difficult to maintain a uniform level of anesthesia with an intermittent method than it is with a continuous drip. Third, the anesthetist must manipulate the apparatus at frequent intervals while injecting the anesthetic solution and does not have both hands free for administration of oxygen, recording the blood pressure, etc. All three drawbacks of the intermittent method are eliminated by the continuous drip.

As to the concentration of pentothal sodium, the experience proved that 5 or 2½ per cent solution can be replaced as a routine by a 1 per cent solution, thus diminishing the danger of phlebitis, since it has been shown that the incidence of this complication is in direct proportion to the concentration of the drug.

To repeat, we wish to stress two technical points, namely, the employment of the drip method and the use of a 1 per cent solution. Only two references to this method could be found in the literature: Solkow<sup>2</sup> and Sister Borrromea<sup>3</sup> reported good results, but the first mentioned author employs it only for relatively short anesthesias and in small doses.

#### TECHNIC

The evening before the operation one of the customary hypnotics is given by mouth. One hour before the operation the customary dose of pantopon and atropine or morphine and atropine is administered subcutaneously. In some instances one of the barbiturates is given per os two hours before the operation, supplementing the aforementioned premedication.

An amount of 1 per cent pentothal sodium solution sufficient for the entire

schedule of operations is made up in the morning, calculating approximately 1.5 Gm. of pentothal sodium per patient. The drug is dissolved in sterile normal saline solution. If the entire amount of this stock solution is not used up, the remaining portion may be saved for the following day, but the solution is never kept longer than twenty-four hours. Approximately 150 cc. of the solution are placed in an open 200 or 300 cc. burette or salvarsan tube suspended from a stand. The burette is supplied with approximately 90 cm. long rubber tubing interrupted by a Murphy drip glass tube and equipped with an adjustable clamp which controls the rate of flow of the solution. The distal end of this tubing is equipped with a Luer metal adapter which is connected with another adapter attached to a 30 cm. long ¼ inch tubing. The distal end of this tubing is mounted with a glass adapter to which a No. 20 gauge, short bevel, one inch long needle is attached. The reason for using two tubings instead of one is that the same burette with the attached tubing may be used for one operation after another, and only the above mentioned second or distal ¼ inch tubing with glass adapter and needle are changed. In this manner blood, which could have entered the tubing, cannot be transferred from one patient to another.

A fairly rapid flow, averaging 100 to 150 drops per minute, is used to induce sleep. As soon as the patient loses consciousness, his jaw is relaxed, the respirations become shallow and the eyelid reflex is abolished, the rate of flow is reduced considerably so that the drip becomes as slow as 4 or 5 drops per minute. The depth of respiration is the main guide in determining the level of anesthesia. No set rules as to the rate can be given because pentothal sodium like any other anesthetic should be administered in accord with the individual's needs.

As soon as the patient is asleep, pure oxygen is administered for approximately one minute and from that time on through-



out the operation a mixture of equal parts of oxygen and nitrous oxide is given by a closed method. The use of oxygen, introduced by Carraways,<sup>4</sup> materially adds to the margin of safety of the method. If the relaxation obtained in this manner is not satisfactory, nitrous oxide is replaced by cyclopropane. In cases in which a complete relaxation is not essential, for instance if a curettage or a breast amputation is performed, helium is given instead of nitrous oxide. Helium is also administered if the patient has a dusky appearance, or it is added to the oxygen toward the end of the operation to bring the patient out of deep anesthesia. When the peritoneum is being closed, the intravenous administration of pentothal sodium may be discontinued if the abdominal wall is well relaxed.

After the patient has consumed approximately 1.5 Gm. of pentothal sodium and is well relaxed, but the operation is not yet finished, enough saline solution is added to the burette to transform the 1 per cent solution into a  $\frac{3}{4}$  or  $\frac{1}{4}$  per cent solution.

In patients who are poor risks the entire anesthesia may be carried out with a  $\frac{1}{2}$  or  $\frac{3}{4}$  per cent solution. Furthermore, 1 cc. of coramine or metrazol may be added to the solution in such cases at the onset of the anesthesia.

A free airway must be maintained at all times. Since the laryngeal reflex is not promptly abolished with pentothal sodium, the airway should not be introduced too early, in order to avoid laryngospasm. The airway is left in the patient's mouth after the operation until it is ejected by the patient. As a rule, patients wake up within the first two hours after the operation. Headaches are very rare, nausea and vomiting are hardly ever observed and, therefore, fluids can be taken by mouth much earlier than after an exclusive inhalation anesthesia, and the postoperative use of sedatives is curtailed.

The relaxation obtained with pentothal sodium compares favorably with that produced by inhalation anesthetics, or

in many instances is superior to them, but it seems to be slightly inferior to the effect of spinal anesthesia.

The blood pressure usually drops during the induction; the initial drop may reach 40 points, but during the rest of the anesthesia it remains on the normal level or stays 10 to 20 points below it.

The average amount of pentothal sodium used in the reported series of major operations was 1.0 to 1.5 Gm., but in exceptional cases the total dose reached 2.5 Gm. In rare instances the operation was not finished when the above mentioned amount of pentothal sodium had been given and in such cases the anesthesia was continued with cyclopropane or ethylene.

Metrazol, coramine and picrotoxin should always be kept in readiness, to be used if a suppression of respiration becomes alarming.

It may be asked: As long as inhalation anesthetics are used in addition to pentothal sodium, why resort to the intravenous anesthesia? The answer is: Inhalation anesthesia is not required in every case and, if used, it only supplements the intravenous administration of pentothal sodium. The amount is usually so small that postoperative nausea and vomiting are conspicuous by their absence. Moreover, the ease of induction, one of the outstanding characteristics of pentothal sodium, is greatly appreciated by the patient, anesthetist and surgeon. Its value cannot be overestimated in certain cases, such as apprehensive patients or those with disruption of the abdominal wall, where struggling or straining during the induction may become disastrous.

Since the introduction of pentothal sodium anesthesia in St. Elizabeth's Hospital by the senior author (J. K. N.) October, 1941, the method gradually gained popularity among other staff members so that from the end of July, 1943 until September 1, 1944, 1462 anesthetics have been administered by the staff of five anesthetists. The operations were performed by forty-one surgeons. In the field

of abdominal surgery the series comprises the following types of operations: appendectomy, cholecystectomy, gastric resection, gastroenterostomy and herniorrhaphy. All the customary operations on the female reproductive organs were listed, including laparotomies as well as vaginal operations. In the field of urology the following procedures were employed: suprapubic prostatectomy, transurethral resection of bladder tumors, cystotomy, hydrocele operation and orchidectomy. The orthopedic surgeons used the intravenous anesthesia for open reductions of fractures. Thyroidectomies, breast amputations, hemorrhoidectomies, amputations of the rectum are included in the series. The youngest patient was fifteen years old and the oldest eighty-seven years. The list contains patients in shock, those with severe anemia, cardiac decompensation, diabetes, obstructive jaundice and thyrotoxicosis.

The following figures demonstrate the popularity of the method: During the month of April, 1944, 111 major operations including one cesarean section have been performed under pentothal sodium anesthesia, and twenty-seven under inhalation anesthesia. These figures do not include children under thirteen years of age.

No serious complications were encountered. Only one case was refractory to pentothal sodium which appeared to have no anesthetic effect. After 2 Gm. of pentothal sodium had been given without result, inhalation anesthesia had to be employed. One patient slept after the

operation about twelve hours, but retained good color and her respiration remained normal. Metrazol and coramine were employed in that case.

The administration of the sulfa drugs is mentioned by some writers as a contraindication to the use of pentothal sodium. However, no ill effects of the combination of both drugs could be noticed in any of our patients who were given both the sulfa drugs and intravenous anesthesia.

#### CONCLUSIONS

Clinical experience in 1,462 consecutive cases showed the intravenous administration of a 1 per cent solution of pentothal sodium by continuous drip to be a dependable method of anesthesia which can be employed in practically all fields of major surgery. Its value lies in the ease of induction, absence of excitement stage, rarity of postanesthetic nausea and vomiting, and very few contraindications, mainly an impaired pulmonary ventilation. The value of the continuous drip method and the use of 1 per cent instead of 2½ or 5 per cent solution is stressed.

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# MODERN FRACTURE DEFORMITY REDUCING SPLINTS

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ACCORDING to Dr. Clark in 1937, the present non-operative mechanical plan of treatment of fractures goes back practically unchanged through the ancient Greek and Egyptian periods to the time of the prehistoric races of the Stone Age.

It is the instinctive plan of treatment. When one sees after an accident, a limb with unnatural mobility, misshapened and shortened, the natural tendency is to pull the limb straight and then apply some immobilizing material to hold the corrected position. This has been the procedure since the dawn of human intelligence. Certain it is that extension and immobilization of the fractured area are fundamental absolutes. To say this, however, does not mean that we should close the book with the conviction that nothing further along mechanical lines can be explored. It is recognized that with the highest skill, with considerable fracture deformity, the methods commonly used are sadly deficient both as to the correction of the deformity and the maintenance of the correction. Also the methods used cause atrophy of the tissues, retarded healing, and a stiffness of the joints persisting long after the bone has united. The many deficiencies of orthodox methods supply the reason for the resort to operative interference.

For many years with gratifying success, I have used an entirely different type of splint construction that makes possible the use of mechanical powers and physiological factors not found in other non-operative procedures. A better understanding of my plan of treatment will be gained by considering the various deficiencies of the present non-operative methods, and then explaining how my splints overcome these deficiencies and make resort to any oper-

ative interference for fresh limb fractures quite unnecessary.

A study of the anatomical structures of the limbs throws light upon some of the shortcomings of orthodox treatment. The long bones are buried in muscle bands inlaid with each other and running fairly parallel with the bone. These muscle bands are attached at one end to adjacent bone structures. In some cases they are not attached to the injured bone but run from one adjacent bone to a bone at the other extremity of the long bone. Taking the femur for illustration, it is readily seen that surface traction upon the skin is first transmitted to the underlying muscles. These underlying muscles are attached to the proximal fragment of the femur or to the innominate bone. Thus adhesive plaster traction over these muscles is first transmitted to the proximal fragment before it has any influence upon the distal fragment.

If one makes traction upon the ankle with counterpressure upon the symphysis pubis, that is bone traction. Mechanically, however, as such extension is not in the normal line of the femur shaft the bone will not return to full normal alignment. Further much of the power applied is wasted stretching more or less distantly unrelated tissues.

Extension between supports placed upon the bones immediately above and below the fractured bone is the primary essential in my plan of treatment. The splint equipment adaptable to fit all conditions makes extension in the normal line of the bone. The bone is thus brought to normal length and alignment without side strain.

In his text book Dr. Stimson proposes in certain cases to angulate the fracture hoping to lock the bone ends and by leverage to bring the limb to a straight position.

Realizing the instability of the bone buried in the muscle tissue there is but scant likelihood of this being accomplished. If it should happen, any amount of safe bandaging over the fractured ends will not retain the correction. It is quite possible for a nerve or vessel to be pinched between the bone ends. It is imperative that the splint be sufficiently anchored to the structures above and below the injured bone to maintain the length and alignment of the part and to prevent side strain. That usual splinting fails to do this is well illustrated in the metal plates and screws that often break or pull out after operative procedures.

Seventy years ago the late Dr. Sayre asserted that with the limb drawn to normal length the muscles automatically return to normal placement. With these encasing muscle bands the bone thus reduced and held will not be displaced.

It has been advised that the bones be moved from side to side. In most fractures the soft tissues are injured only in the pathway of the thrust of the bone. Crushed and lacerated tissues in compound injuries are the great exception. Do we realize the force that is transmitted to the jagged bone ends when we apply leverage to the bone? Such manipulations cannot help but give added injury to the soft tissues.

Bandaging the fractured area will hold the correction to some extent; but if efficiently tight, it has a retarding influence upon the circulation and the nutrition of the parts. This is seen in the puffed hands which are so prevalent.

The various long bones have a limited area of contact with adjoining bones, yet they are ample to bear all the strain of heavy physical exertion. A proper appraisal of the bone structures immediately above and below the fracture will give a more extended area of pressure contact for the restoration of the normal length of the injured member. My splints make distention between comfortable anchorages upon the bone structures above and below the fractured bone. Activity of vessel, nerve and muscle function is not disturbed. The

splint designed for the different bones leaves the fractured area exposed for observation and any necessary treatment. These splints permit mobility of the joints. Prolonged immobilization of the joints means atrophy of all the tissues, retarded healing and a stiffness of the joints that persists long after the bone has healed.

Function, an ability to use the limb is of first importance. I contend that function plus a practically normal restoration of contour is what every victim desires. The opinion of the late Dr. Ashhurst that if a workable function is restored we can accept deformity as only an apology for the limitations of the treatment.

There are a few surgeons who still advocate delayed reductions. Urist and McLaen<sup>1</sup> from a complete extensive investigation upon rats have proved that there is fibro-connective tissue organization twenty-four hours after injury. They found microscopical bone deposits within three and four days. With immediate reduction the exudate is liquid; the muscles and fibrous tissues are not actually shortened.

Swelling is not a contraindication. I would cite a man with comminuted fractures of the astragalus and os calcis of both feet. The parts were swollen with extravasated blood near to the bursting point. The arches were restored immediately and after recovery he returned to his old carpenter job.<sup>2</sup>

The limitations and deficiencies of orthodox methods of treatment of fracture deformities are well known to surgeons. It will be my endeavor to show how with a quite different plan of treatment much of the trouble can be eliminated or distinctly improved.

I have intimated what I consider to be the basic solution of the troubles that are confronted. It is a correctly appraised use of the adjoining bone structures for the purpose of drawing the limb to the normal length and the alignment of the injured bone. This proposition requires a different type of splint equipment. Through the years following an initial rather crude con-

ception of the requirements, I have developed a splint equipment suitable for all splintable fractures that has been a revela-

Swivelly attached to the sides of the ring are splint arms that project downward underlapping the pieces extending upward

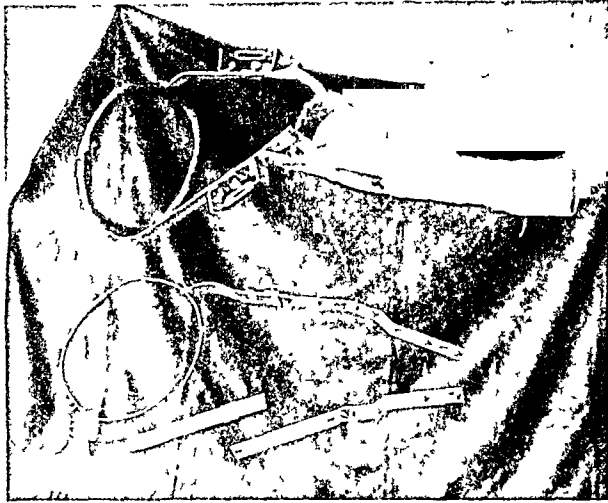


FIG. 1. Splint for all femur fractures; knee flexion cross brace removed after reduction.

tion to me as to what can be accomplished both in the correction of the deformity and in the contribution to rapid recovery.

There are separate splint designs for the different bones. The femur splint useful for all femur fractures (Fig. 1) illustrates the principles involved. On the leg and foot is a strictly unpadded cast molded to all the contours of the part. Imbedded in the upper part of the cast are metal plates that have pins on their projecting ends that are set to lie opposite the axis of the knee joint. To these pins are attached splint arms that project upward on both sides of the femur. With the limb straight this cast bears upon the tarsal and metatarsal bones. Flexed, the tibia and fibula are included.

The support above against the pubic rami, the ischium and the iliac wing is a padded elliptical ring. This ring is composed of two semi-elliptical pieces that can be bent out or in for a stout or thin patient. Holes in one piece and a screw pin in the other permit adjustment to the required diameter. The ring being elliptical, the rotation of the limb is under control. The foot can be turned into any position of inversion beyond the power of the patient to change.

from the knee. These overlapping arms are enclosed in clampable sleeves. With manual and then screw turnbuckle distention the limb is brought to the desired length and then the overlapping arms are clamped.

With this plan there is no attempt to correct the deformity by previous manipulation. The splint is applied first and its operation corrects the deformity and retains the correction. There is no guess work. The splint, making distention in the normal line of the bone, compels the bone to return to good apposition and alignment.

With the splint stabilizing the limb under distention, the bones slide back through their path of traumatic egress to good apposition and alignment without pain. Joint function is preserved during the treatment.

The question of undue pressure is one that arises naturally. It will be noted that the pressure is distributed over a considerable area of bone tissue. The pressure is subject to adjustment at any time. The amount of pressure necessary to overcome the initial resistance is greater than necessary to retain the bone in corrected position. Immediately after reduction the pressure is let down until the patient states

that there is no pressure discomfort. This stage is quite sufficient to overcome the normal tonal contraction of the tissues.

Smith-Pedersen nail holds the front page. Enthusiastic surgeons at every cross road take this as the proper procedure. This nail,

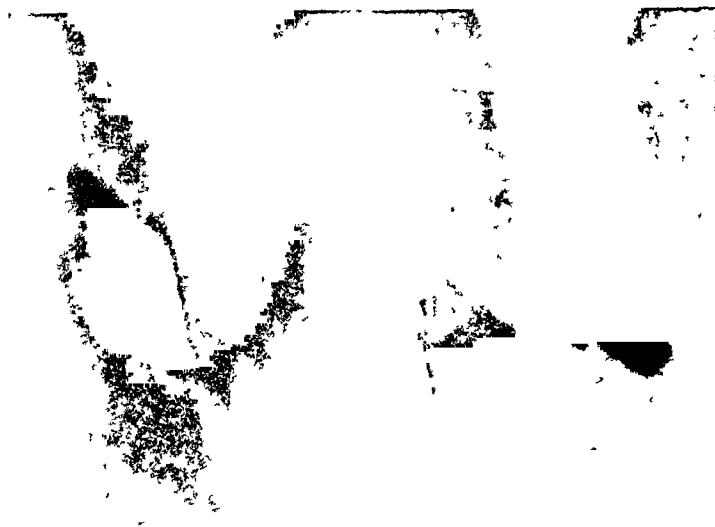


FIG. 2.

FIG. 3.

FIG. 2. Actual femur overlap one and seven-eighths inches.

FIG. 3. Reduction, lateral manipulation indicated; no anesthesia.



FIG. 4.

FIG. 5.

FIG. 4. Deformity after three attempts at correction elsewhere.

FIG. 5. Correction, no anesthesia, forearm splint (Masland).

For many years the journals have been filled with all sorts of operative work to improve the situation. At the present the

really a spike, crushes and destroys much of the wonderfully planned cancellated arch of the neck. Unless the overlap has

been corrected first, the spike goes diagonally through the uncorrected deformity. It gives a false sense of security, but cases are reported in which the nail has gone cruising through the soft yielding bone, through the acetabulum and into the pelvic

and various rotation deformities are all susceptible of fine control and correction:

The first x-rays, (Figs. 2 and 3) are those of a muscular negro forty-seven years of age with a fracture in the middle third of the femur. The muscles of the thigh are the most



FIG. 6.

FIG. 6. Deformity persisting after orthodox attempt at correction.



FIG. 7.

FIG. 7. Anatomical replacement, humerus splint (Masland).

cavity. A patient was referred to me in whom the nail hit the cortical bone of the proximal fragment and slid onward before engaging. The result was that the deformity was increased. There was no union and there was necrosis of the head.

After twenty years of experience I am convinced that my plan of treatment will eliminate the necessity for operative interference for fresh fracture deformities.

In the following cases I wish to show that muscle resistance, muscle intervention

powerful group of muscles in the body. A muscle in contraction is a powerful force. When it is relaxed it is the most stretchable tissue in the body. The stretch of the quadriceps extensor cruris with flexion of the knee illustrates this point. As my splints produce a smooth unirritating reduction I have never seen a muscle in spastic contraction during the procedure. Figure 2 shows one and seven-eighths inches actual overlap. The correction shown in Figure 3 was secured with no difficulty and with no need for any anesthetic. The splint was removed in eight weeks. Four months after

injury with compact bone union he returned to his former hard labor job.

The following cases are interesting from the standpoint of comparison of methods of treatment. They were first treated by men of wide experience and acknowledged ability.



FIG. 8. Comminuted fracture of the trochanter, third day; nailing proposed.

was applied and without difficulty the rotation was corrected and the bone ends brought to practically anatomical alignment. The subsequent course was uneventful.

The next case (Figs. 8 and 9) is that of a woman seventy-four years of age, five feet two



FIG. 9. Reduction femur splint (Masland), no anesthesia; free movement of the knee and hip.

Figures 4 and 5 are the x-rays before and after correction by my method of the forearm of a girl seven years of age. There is a fracture of both bones of the forearm with the distal fragments rotated ninety degrees. Here one can believe that there is plenty of muscle intervention. The child spent a week in a college hospital where two attempts were made at correction. After failure to correct, an operation was proposed. The mother took the child to a second hospital where a third futile attempt at correction was made. My forearm splint was applied on the tenth day. The child was much engrossed watching the application of the splint. When the job was completed with the correction shown in Figure 5, she looked up at me with a winsome anxious expression and asked, "Doctor, when will you set my broken bones"? This is interesting in that even after ten days the muscles returned to normal placement. Prompt union followed.

The next case (Figs. 6 and 7) is that of a temperamental Hebrew woman sixty-five years of age, quite stout, with a spiral oblique fracture of the humerus. Figure 6 shows the cast that had been applied after an attempt had been made to correct. An operation was advised for better correction. She refused and her family physician brought her to my office. With the patient seated in a chair, my humerus splint

inches tall, and weighing 184 pounds. She had a comminuted fracture of the left femur. There was a fracture along the base of the neck and a transverse fracture across the great trochanter. She spent three days in a hospital in the one position and developed a bed sore the size of a silver dollar. The family refused to permit a Smith-Pedersen operation and took her home. She was taken to the Northeastern Hospital where I applied my femur splint the evening of the third day. Owing to the sensitive skin and the overlying flaps of abdominal fat, moderate extension was applied. The eversion of the limb was changed to moderate inversion. The properties of the splint prevent the patient from changing this position. Malgaigne's assertion that correction of the eversion is most important should receive more attention than is given it.

Keeping a dry bed, changing her position frequently, and careful supervision of the pressure from the buttock ring resulted in the healing of the original bed sore and no further skin lesion. She suffered from rheumatic hypertrophic osteo-arthritis centered in the knee. She had no fracture pain during the treatment.

Six weeks after injury the x-ray showed an unusual deposit of callus for one of her age and general physical condition. The splint was



removed at this time. Two weeks later she was given crutches. Ability to walk has been progressive with her increasing measure of confidence. Function is normal. After four months she bore her full weight on the limb with no discomfort.

Patients with hip fractures in whom other factors warrant can be placed in a wheel chair immediately after the reduction. Crutches are permissible with those familiar with and able to use them.

These cases show that whatever the type of rotation or shortening, the splint compels a return to practically normal length and alignment.

Apposition of the bone ends, the most

important contribution to bone union, can be secured in all prompt reductions of the deformity.

These cases and many others which might be cited demonstrate clearly that the inherent difficulties encountered in the commonly used operative and non-operative methods can be practically eliminated with the use of these splints which incorporate modern and efficient mechanical and physiological features.

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PATHOLOGICAL dislocations are the result of disease and are not treated as traumatic conditions. Congenital dislocations are developmental, and have no relation to traumatism.

From "Fractures and Dislocations for Practitioners" by Edwin O. Geckeler (The Williams & Wilkins Company).

# SUBPHRENIC ABSCESS

WITH SPECIAL REFERENCE TO INTRATHORACIC COMPLICATIONS

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**S**UBDIAPHRAGMATIC, or subphrenic, abscess is not a common condition and probably with the increased use of chemotherapeutic agents it will become even less common. Certainly, the use of chemotherapeutic agents for the control and prevention of peritonitis has been wonderfully effective. Since in almost all cases subphrenic abscess is a complication of peritoneal inflammation, it seems logical that control or prevention of peritonitis will prevent the development of subdiaphragmatic abscesses to a great extent. Nevertheless, subphrenic abscess is a complication that can result from any inflammatory process in the abdomen or from any abdominal operation; it is a serious complication and is particularly serious when thoracic complications are manifest.

## DATA ON OUR SERIES

From 1930 to 1942 inclusive, eighty cases of subphrenic abscess have been seen at the Mayo Clinic. In fifty-nine cases (74 per cent) the abscess had developed before the patient entered the clinic, and most of these patients had undergone one or more attempts at surgical drainages prior to admission. In general, it can be said, therefore, that our series represents the late phases of the disease and consequently a large number of complications were present. Thoracic complications, therefore, will be emphasized in this paper but first we shall consider subphrenic abscess generally.

## PATHWAYS OF INFECTION AND ETIOLOGIC FACTORS

The subphrenic spaces can become infected in a variety of ways. According to

Hochberg,<sup>7</sup> the usual routes are (1) by direct extension from the peritoneum or contiguous organs, such as the gallbladder, stomach, duodenum, kidney, spleen, pancreas, and so forth; (2) by distant extension, as from appendiceal infection, and pelvic abscess; (3) by rupture of a hepatic abscess and thoracic empyema sac into the subphrenic spaces and by extension from osteomyelitis of a rib and so forth; (4) by retrograde lymphatic spread from a pulmonary abscess or thoracic empyema; (5) by hematogenous spread from osteomyelitis, septicemia or furunculosis, and (6) by direct implantation by injury to an anatomically related organ. Obviously, the simplest and most logical mode of spread of infection to the subphrenic region is by extension from inflammatory processes within the abdomen. Ochsner and DeBakey<sup>11</sup> found that subphrenic abscess was a complication of an intra-abdominal suppurative process in 84 per cent of their 3,608 cases collected from the literature and encountered in their practice. In our series almost every abscess arose from intra-abdominal inflammation of some kind. According to the literature, extension of thoracic infection into the subphrenic region was responsible for only about 2.5 per cent of cases, and trauma for only 2.1 per cent. Undoubtedly, infection of the subphrenic region can develop by any of the routes suggested by Hochberg but infection by any route except direct extension from intra-abdominal disease must be rare.

Some degree of subphrenic inflammation may occur in many cases in which suppuration does not appear. Ochsner and Graves<sup>12</sup> have stated that subphrenic inflammation subsides without the devel-

opment of true suppuration in about two-thirds of all cases. In thirty-two of 175 cases of subphrenic inflammation reported by Faxon,<sup>6</sup> the clinical course, physical findings and roentgenologic studies suggested subphrenic inflammation but the inflammation subsided without surgical interference. In an additional six cases operation was performed and no pus was found. Faxon concluded, therefore, that in thirty-eight cases (22 per cent) of his series, subphrenic inflammation had subsided without drainage. All agree that probably subphrenic inflammation does subside without suppuration in a high percentage of cases.

In about 31 per cent of cases collected by Ochsner and DeBakey,<sup>11</sup> the subphrenic or subdiaphragmatic abscess resulted from suppurative disease of the appendix, in 28 per cent from lesions of the stomach and duodenum and in 13 per cent from lesions of the biliary tract. In 35 per cent of the eighty cases we reviewed, the abscess developed from diseases of the stomach and duodenum, in 22 per cent from diseases of the gallbladder, and in 22 per cent from lesions of the appendix. The incidence of diseases of the gallbladder, stomach and duodenum as etiologic factors in our series is relatively high and that of appendicitis is relatively low as compared to the incidence in other reported series. This disparity undoubtedly is explained by the fact that diseases of the upper gastrointestinal tract are seen at the Mayo Clinic much more frequently than is appendicitis.

#### ANATOMY OF SUBPHRENIC SPACES

A brief review of the anatomy of the subphrenic spaces is essential to any discussion of inflammations in this region. Martinet,<sup>9</sup> of France, and Barnard,<sup>1</sup> of England, were the first to describe accurately the subphrenic spaces from a surgical point of view and all subsequent descriptions of this region have drawn heavily from their works. From a surgical viewpoint, the subphrenic or subdiaphragmatic

region includes the region extending from the diaphragm above to the transverse colon below. The intraperitoneal subphrenic region is subdivided by the ligaments of the liver and adjacent structures essentially into three spaces on the right side and one on the left side. The right anterior and posterosuperior spaces are bounded by the diaphragm above, by the liver below, and are separated from each other by the coronary ligament of the liver and its lateral extensions. The right inferior space is bounded by the kidney posteriorly, the liver above, the round ligament of the liver medially and the transverse colon below. The space on the left side is bounded by the diaphragm above, by the left lobe of the liver below and to the right, by the spleen to the left, the coronary and falciform ligaments to the right and by the stomach and omentum below.

#### SITE OF ABSCESS

According to most reports, the most common site of subphrenic abscess is the right side and especially the right superior spaces. It is logical that most abscesses should be on the right since the appendix, gallbladder and duodenum are all on the right side and are the most frequent sites of conditions which lead to subphrenic inflammation. In 89 per cent of the cases in our series, the abscesses were on the right side. According to Carter,<sup>3</sup> left subphrenic abscesses are usually the result of pelvic inflammation which extends to this region along the colic gutters. The predominance of infections in the superior spaces on the right side is due to the fact that although the inferior spaces communicate freely with the peritoneal cavity, the suprahepatic region is more nearly a closed space and, therefore, offers conditions conducive to the development of a localized suppurative process. Furthermore, Overholt and Donchess<sup>13</sup> have shown by ingenious experiments that a definite negative pressure is present in the subphrenic spaces which, in association with

diaphragmatic motion, tends to suck in infection. In 66 per cent of Faxon's cases and in 67 per cent of Ochsner and De-Bakey's cases, the suprahepatic space was invaded. An abscess in one space can extend to others readily and in our series so many patients were seen late in the course of the disease that the abscess was not commonly localized to one space. It was impossible to determine the exact location of the primary subphrenic abscess in enough cases to be of any statistical value.

#### THORACIC COMPLICATIONS

The thoracic complications of subphrenic abscess constitute the greatest danger and it is with these complications that we are particularly concerned. The diaphragm offers an efficient barrier to the extension of thoracic infection to the abdomen but because of the nature of the lymphatic circulation, inflammatory subphrenic lesions have a tendency to extend through the diaphragm. Lemon and Higgins<sup>8</sup> studied the lymphatic absorption through the diaphragm and found that particulate matter seemed to be taken up diffusely on the undersurface. It passed between the mesothelial cells of the peritoneum into tiny lymphatic vessels and was carried between the muscle bundles. They demonstrated that normal muscular contraction of the diaphragm contributed to passage of the particulate matter through the diaphragm. The transfer from the peritoneal to the pleural surface was rapid, requiring only from three to five minutes when the muscle was normal and from ten to twelve minutes when it was paralyzed. It also was observed that the lymphatics of the right leaf of the diaphragm carried a greater amount of material than those of the left, even when the muscle of the left side was normal and that of the right side was paralyzed. Since the plexus of lymphatic vessels filled rapidly and the lymph was separated from the pleura only by pleural mesothelium, Lemon and Higgins concluded

that by mere continuity of tissue, infection might readily set up inflammatory reaction of the pleura and cause effusion. Material injected into the pleural space was not absorbed by the pleural covering of the diaphragm. It is, therefore, not difficult to understand why the most frequent complication of subphrenic abscess is thoracic inflammatory process.

When thoracic complications occur, the pulmonary symptoms may be so striking that the patient is thought to have primary intrathoracic disease and serious diagnostic errors are made. The problem is often further confused by the fact that the first important symptoms and signs of the subdiaphragmatic abscess may be caused by the intrathoracic extension. It has been Dexter's<sup>5</sup> experience, as well as our own, that the diagnosis of subphrenic abscess too often is made after pulmonary complications have occurred.

Whether empyema, pneumonitis or bronchial fistula develops after perforation of the diaphragm by a subdiaphragmatic abscess depends on the existence of a free pleural space. If the visceral and diaphragmatic pleurae are adherent to the diaphragm, the abscess perforates directly into the lung, causes pneumonitis and eventually bronchial fistula. If the basal portions of the pleurae are not adherent to the diaphragm, perforation is followed by extensive empyema; the empyema may rupture later into a bronchus.

Beye<sup>2</sup> has reported thirty-one cases of subphrenic infection, in twenty-three (74 per cent) of which pulmonary complications developed. In his series, gross perforation of the diaphragm occurred in fifteen cases. Overholt and Donchess<sup>13</sup> agreed with Beye that pleural effusion was often an early sign of the development of subphrenic abscess and that empyema was the commonest thoracic complication. In Steele's<sup>14</sup> series of forty-eight cases of subphrenic abscess, the incidence of bronchial fistula was 12.5 per cent. The development of a bronchial fistula did not affect the mortality rate in Steele's series which was

50.8 per cent in cases without fistula, and 50 per cent in the cases with bronchial fistula. In Ochsner and DeBakey's<sup>11</sup> 3,608 collected and personal cases, the most important complications, in order of frequency, were pleurisy, perforation of the diaphragm, empyema and bronchial fistula. In their total series of cases collected from the literature the incidence of bronchial fistula was 10.5 per cent. The gravity of the thoracic complications is demonstrated by the mortality rate among the seventy-five patients whom Ochsner and DeBakey had seen personally. It was 50 per cent among those who had thoracic complications and 16.3 per cent among those who did not have thoracic complications.

#### CLINICAL FEATURES OF SUBDIAPHRAGMATIC ABSCESS

As previously stated, pulmonary symptoms may be so prominent that a diagnosis of primary intrathoracic disease often is made. However, some of the pulmonary complications are insidious and completely overshadowed by the presence of the subphrenic abscess. This is especially true of a small pleural effusion which occasionally is an early manifestation of subdiaphragmatic abscess. Elevation of the diaphragm on the affected side may obscure basilar pneumonitis which often precedes the rupture of an abscess through the diaphragm. In contrast to these complications, perforation of a subdiaphragmatic abscess into a bronchus is usually sudden and dramatic. When this occurs, the cardinal symptom is a sudden attack of coughing with expectoration of a large amount of purulent sputum, which usually has a foul odor. Such paroxysms have been known to cause sudden death from drowning or have given rise to a fulminating and fatal bronchopneumonia. Immediately after the paroxysm, the patient is usually much improved by the drainage of the abscess. However, in most instances, the cough and expectoration continue intermittently. Rarely is such an episode followed by spontaneous recovery.

#### DATA ON OUR SERIES

The age and sex incidence in our group of eighty cases of subphrenic abscess is in agreement with most series. The average age was forty-two years. The age incidence is shown in Table 1. Sixty-seven (84 per cent) of the patients were males.

TABLE 1  
AGE INCIDENCE, IN EIGHTY CASES OF  
SUBDIAPHRAGMATIC ABSCESS

Age, Years	Cases
0 to 9.....	3
10 to 19.....	3
20 to 29.....	6
30 to 39.....	18
40 to 49.....	23
50 to 59.....	21
60 to 69.....	6

Subphrenic abscess is, of course, a complication of a pre-existing inflammatory process within the abdomen. The causative factors of the abscesses in our series of eighty cases are given in Table II. As in other series, the right side was involved most frequently. It was affected in 89 per cent of the cases in our series.

TABLE II  
ETIOLOGY, IN EIGHTY CASES OF  
SUBDIAPHRAGMATIC ABSCESS

	Cases
Lesion in stomach or duodenum.....	28
Perforated ulcer—18	
Postoperative stomach—10	
Disease of gallbladder.....	18
Ruptured gallbladder—7	
Postoperative gallbladder—11	
Appendicitis.....	18
Amebiasis.....	4
Actinomycosis.....	3
Pelvic abscess (salpingitis).....	3
Osteomyelitis.....	2
Injury.....	1
Tuberculosis.....	1
Unknown.....	2

Thoracic complications were present in fifty-two cases (65 per cent) of our series. Bronchial fistula evidenced by cough and expectoration of large quantities of pus was present in thirty-two (40 per cent) of the cases by the time a diagnosis of subphrenic abscess was made, and in ten cases empyema without bronchial fistula was present. Pneumonia and pleural effusion were found in four and six cases, respectively.

## DIAGNOSIS AND PROGNOSIS

The high incidence of serious thoracic complications in our series indicates that the medical profession is not sufficiently aware of the problems of subphrenic abscesses. Subphrenic abscess is a complication which can occur after any abdominal operation or inflammatory process within the abdomen and should be considered as a possibility more frequently than it has been in the past. A diagnosis of subphrenic abscess requires first a consideration of its possible occurrence. The old adage, "Pus somewhere, pus nowhere, pus under the diaphragm," should be remembered more frequently.

The diagnosis is not difficult in most instances. A history of an abdominal condition which could cause a subphrenic abscess, with evidence of a suppurative process manifested by fever and elevation of the leukocyte count which cannot be accounted for otherwise is sufficient to warrant investigation. Roentgenographic studies of the diaphragm with anteroposterior and lateral views with the patient in the erect position are of greatest value. The presence of a fluid level under the diaphragm was demonstrated in this manner in about 25 per cent of our cases. Marked elevation and immobility of the diaphragm are significant. It is generally agreed that diagnostic aspiration should never be attempted in cases of suspected subphrenic abscess. The subphrenic region is not anatomically suited to such procedures since it is necessary to traverse either the peritoneal or pleural cavities with the needle in such cases and the danger of setting up infection in these cavities is very great. Furthermore, failure to obtain fluid proves nothing. Exploratory operation is without question the logical and safe procedure in cases of suspected subphrenic abscess. The seriousness of delayed diagnosis of subphrenic abscess and the development of pulmonary complications is evidenced by the fact that in our series the mortality rate in the fifty-two cases in which pulmonary complications

were present was 44 per cent, while the mortality rate in twenty-eight cases in which thoracic extension was not present was 32 per cent. Then, too, the presence of a bronchial fistula seems to be of significance prognostically. Of thirty-two patients in our series who had fistula, sixteen (50 per cent) failed to survive, whereas the mortality rate in forty-eight cases without fistula was 29 per cent.

The etiology of the subphrenic abscess is also of prognostic significance. In three cases in our series, abscesses caused by actinomycosis and in one case caused by tuberculosis were fatal.

While cases have been reported in which subphrenic abscess apparently has been evacuated and healed by spontaneous evacuation through bronchial fistula, it is generally recognized that the mortality rate in cases of subphrenic abscess will be more than 90 per cent unless surgical drainage of the abscess is established. Obviously, the optimal time to establish drainage is before thoracic complications have developed. The possibility of subphrenic abscess, therefore, must be kept in mind and this becomes the serious responsibility of anyone dealing with any inflammatory abdominal process or abdominal operations.

## OPERATIVE PROCEDURES

Clairmont and Meyer,<sup>4</sup> in 1926, were the first to suggest the extraserous approach to subphrenic abscesses. It is unfortunate that their suggestion was neglected for so long because this approach is now obviously the safest and most logical one in most cases of subphrenic abscess. The various one-stage and two-stage transpleural approaches and the transperitoneal approaches all have had their periods of favor but now have generally fallen into disuse. That the type of approach to subphrenic abscess is a serious consideration is well illustrated by the mortality figures reported by Faxon and by Ochsner and DeBakey for different operative procedures. Faxon reported a mortality rate of

55 per cent in cases in which drainage was established by the transperitoneal route, 41 per cent in cases of drainage by the transpleural approach, and 27 per cent when drainage was established by the extraserous route. Ochsner and DeBakey reported a mortality rate of 50 per cent in cases in which drainage was established transperitoneally, 42.8 per cent when the transpleural approach was used, and 20 per cent when extraserous drainage was instituted. Obviously in some cases subphrenic abscess may be complicated by empyema for which a transpleural type of operation may be necessary, and in other cases by some intrahepatic abscesses which may have to be drained transperitoneally. In most instances, however, if the diagnosis is made sufficiently early in the course of the process, adequate and safe drainage can be established by the extraserous route.

The approach to abscesses situated anteriorly, as indicated by the lateral roentgenograms, is made by an incision just below the costal arch. The incision is carried down through the muscle and posterior fascia to the peritoneum. A line of cleavage is established just outside the peritoneum and, by blunt dissection, the peritoneum is stripped from the under-surface of the diaphragm until the induration and fluctuation of the abscess are demonstrated. An opening is then made into the abscess sufficiently large to establish adequate drainage.

For abscesses situated posteriorly it is necessary to resect the twelfth rib. Melnickoff<sup>10</sup> has demonstrated that in about 62 per cent of cases the pleura extends to the twelfth rib but that it never extends as low as the spine of the first lumbar vertebra; therefore, a transverse incision is made across the periosteal bed of the twelfth rib at the level of the first lumbar spine and, by blunt dissection, a line of cleavage is established below the diaphragm but outside the fascia enclosing the kidney and adrenal glands, and the dissection is extended until the abscess is reached.

These approaches can be carried out quickly and easily even on patients who are extremely ill. After establishment of adequate external drainage of these subphrenic abscesses, rapid improvement takes place and in cases complicated by bronchial fistula, the fistulas close and cough clears up rather rapidly. If the bronchial fistulas have been present for some time before drainage of the subphrenic abscess is established, bronchiectasis may develop in the lung from chronic inflammatory changes in the bronchi, even though the abscess heals satisfactorily. This fact indicates further the importance of early diagnosis and drainage of subphrenic abscess.

#### SUMMARY

We will summarize briefly the outstanding points of our study. Subphrenic abscess is a complication that can occur after any abdominal operation or any inflammatory process in the abdomen. It too frequently is not recognized until serious thoracic complications have developed. Thoracic complications which are late complications of subphrenic abscess are responsible for the high mortality rate of subphrenic abscesses. Early recognition and treatment of subphrenic abscess will prevent thoracic complications.

The extraserous approach to subphrenic abscesses is the safest and most effective means of treating subphrenic abscess.

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To increase exposure, especially in the upper abdomen, a transverse incision may be made through the skin and anterior and posterior sheaths of the rectus muscle at right angles to a median incision. This type of exposure may be indicated in certain operations upon the gallbladder, stomach, pancreas, spleen, and transverse colon.

From "Operations of General Surgery" by Thomas G. Orr (W. B. Saunders Company).



# PLASTIC RECONSTRUCTION OF ACQUIRED DEFECTS OF THE EAR

WITH CASE REPORTS

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**A**CQUIRED defects of the ear are due to a number of factors among which the most important are trauma, infection, malignant growths, burns of the face, usually resulting in a partial loss of the ear, and syphilitic ulceration. Injuries about the head and face since the advent of mobilization and the increased magnitude of the Army training program in mechanized warfare, and actual combat have become much more common, and as a natural consequence new problems in plastic reconstruction have presented themselves.

In the cases reported we are dealing with traumatic, partial or complete avulsion of the auricle following accidents with mechanized equipment, such as automobiles, jeeps, motorcycles and trucks.

## ANATOMY OF EXTERNAL EAR

Anatomically the external ear consists of auricula and the external acoustic meatus, the former being connected to the surrounding parts by ligaments and muscles and to the external acoustic meatus by fibrous tissue. It is made up of a framework of a single piece of thin, intricately shaped, yellow fibrocartilage which gives form to this part of the ear, being absent only in the lobule, which consists of fibroareolar tissue covered by skin, and between the tragus and beginning of the helix. The cartilage is covered with thin integument, there being scant intervening subcutaneous tissue; very fine hairs covering the skin and furnished with sebaceous glands are more numerous in the concha and scaphoid fossa.

The arterial arrangement and subsequent great vascularity is such that the

external ear receives a rich blood supply from the anterior auricular branch of the superficial temporal, the occipital and posterior auricular branches of the external carotid, thus making possible a variety of reconstructive procedures.

In the drawing below an attempt has been made to give an accurate conception of the external ear with all of its important structures applicable to this type of work. (Fig. 1.)

In spite of many articles and opinions to the contrary, the auricle does aid in hearing and the localization of the origin of sound; hence, plastic operations are not merely cosmetic measures, but in frequent instances there is a marked improvement in hearing following surgery. From the standpoint of appearance, loss of tissue is quite important, particularly in individuals who cannot conceal the defects; an appropriate coiffure readily hides the defect in women. One must keep both the functional and high cosmetic standards required in mind when planning repair.

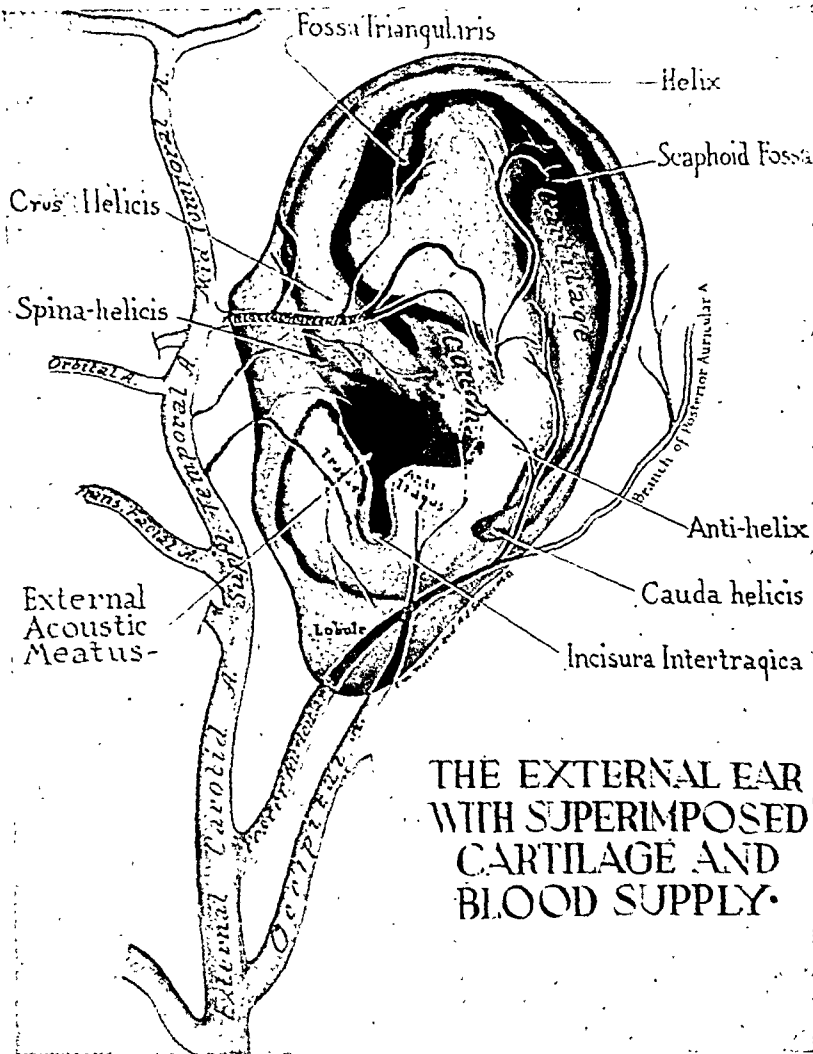
The repair of partial losses of the ear may be performed by means of a folded flap taken from the post-auricular region as illustrated in Figure 2.

It has been a general concession that reconstruction of the external ear is a most difficult and tedious problem in plastic surgery because of its complicated structure and its isolated position. As recently as 1929, A. D. Davis remarked that "many attempts at correction have resulted in an end result that looked more like cabbage than an ear."

Our goal in the complete or partial reconstruction of the external ear is seven-fold physically: It must be the correct size;

it must be similar in outline to the opposite ear; there must be an equally divergent angle from the head; it must be the same

side for there will be some slight shrinkage of both the soft and the hard tissues, particularly is this true during the first



### THE EXTERNAL EAR WITH SUPERIMPOSED CARTILAGE AND BLOOD SUPPLY.

FIG. 1. Photograph of original drawing of the external ear showing the origin of the blood supply in relationship to the cartilaginous framework and integument.

relative height; the new auricle must retain its size and shape permanently; the proper rigid and soft tissues must be utilized which may be flattened into contours and curves as the normal ear, and lastly the coloring of the new ear must compare favorably with that of the normal ear. At best we approximate the intricate design of nature hence an adequate plan is necessary for success in reconstructing an auricle. The immediate final reconstruction should be slightly larger than the opposite

year. The tendency of reconstructed auricles to shrink has been one of the apparently insurmountable difficulties of the task of reconstruction; therefore, it is better to have an abundance of tissue for it is easier to discard than go after more tissue.

One of the prime problems in the reconstruction of a new external ear is the formation of an adequate support and reproduction of the various eminences and depressions, and the external auditory

canal. Best results are obtained when the framework consists of utilizing autogenous costal cartilage, usually from the eighth later in addition to having the decided disadvantage of not being able to make them look life-like. Attempts at permanent



FIG. 2. While on maneuvers in July, 1942, this soldier, aged twenty-four, overturned in a jeep fracturing his left jaw and losing the upper portion of the right ear. A lateral view of the pre-operative appearance is shown in (a); soon following admission to the hospital, a flap was elevated from the posterior auricular region and sutured to form the helix as shown in (b) on the eighth postoperative day, and at the same time a split thickness graft was sutured in the bed of the elevated flap. Twenty-one days later the attached flap was crosscut in a manner that the hair-line was maintained and the flap then accurately approximated to form the helix, scaphoid fossa and part of the fossa triangularis. The postoperative appearance is shown in (c) through (f) taken seven weeks following the first stage.

and ninth ribs, nasal septum cartilage in adults, or a properly shaped bone graft from the iliac crest (used when other methods are impracticable).

Evidence at the present time still indicates that autogenous costal cartilage tends to maintain its original cellular structure following transplantation for the longest period. Where the ear is small enough, we have used the cartilage of the nasal septum with very presentable end results. (Fig. 3.) There has been that group which utilized foreign material such as ivory, wire, wax, celluloid, plastics or even metal, but they eventually reacted as all foreign bodies do ultimately, and were extruded sooner or

results in this group have not been reliable. Others, such as Gillies and Greely, have used donor cartilage taken from another individual, usually the maternal ear cartilage, and there has been a general trend toward using cartilage from some member of the family with similar blood types; but this is not essential, for the survival of cartilaginous homografts is good not appearing to depend upon blood grouping. Their behavior is clinically similar to cartilaginous autografts. Having decided upon the rigid support to be used, a flap, which goes to make up the fossa of the helix, is outlined in the temporomastoid region, making certain that it does not

extend beyond the hairline for obvious reasons and that it is at the same level as that of the existing opposite ear. The

size of the cartilage in order that the skin fits snugly into the contours of the cartilage, but is not under undue tension.



FIG. 3. Photographs of a soldier, aged twenty-three, with an avulsion of the right pinna as a result of being thrown against one of the tarpaulin staves when the truck in which he was riding ran into a ditch on January 30, 1943. Two months later he was admitted for reconstruction of the ear. (a) is the appearance upon admission; nasal septum cartilage was utilized for the supporting structure. (b) shows the neck flap attached to the cartilage supported mastoid flap, forming the helix. (c), (d), (e) show the postoperative appearance taken twelve weeks following the first stage. Lobe reconstruction will complete the case. (Surgeon on this case was Lt. Colonel G. K. Lewis, M.C., with Major G. M. Sanes, M.C. and author assisting.)

incision for emplacement of the patterned cartilage is usually made along the posterior inferior border followed by careful undermining, of the skin only, beyond the actual

After healing has taken place, the patient is ready for the next stage, the first step of which consists of incising the previously outlined ear down through the temporal

fascia and the cervical fascia covering the sternocleidomastoideus insertion in the temporomastoid region and elevating the

layer of 4 per cent xeroform gauze in petrolatum usually suffices as the stent. The second step in this stage is the prepara-



FIG. 4. Photographs of a soldier accidentally struck in the left ear with a drinking glass causing a laceration involving the helix, scaphoid fossa, limbs of the anti-helix, the fossa triangularis, and cauda helix through the entire thickness of the ear and part of the concha. (a) and (b) are the immediate preoperative appearances. The repair was completed within two hours following the injury, (c) and (d), the cartilage in this case, being sutured with fine No. 000 white silk and the skin with No. 000 black silk. An uneventful recovery occurred and (e) and (f) are photographs taken on the twenty-seventh postoperative day.

cartilage containing flap. A split thickness graft is then placed behind the ear flap and stented into place; a gauze roll with a

tion of a flap for the required soft tissue reconstruction. In the male the skin of the lower neck is usually the most applicable

for it matches the skin of the ear in color and texture fairly well and is thinner than that of the upper portion of the neck or of

adjustments but this is not a difficult problem, for with patience most of the finer details of contour may be attained. The

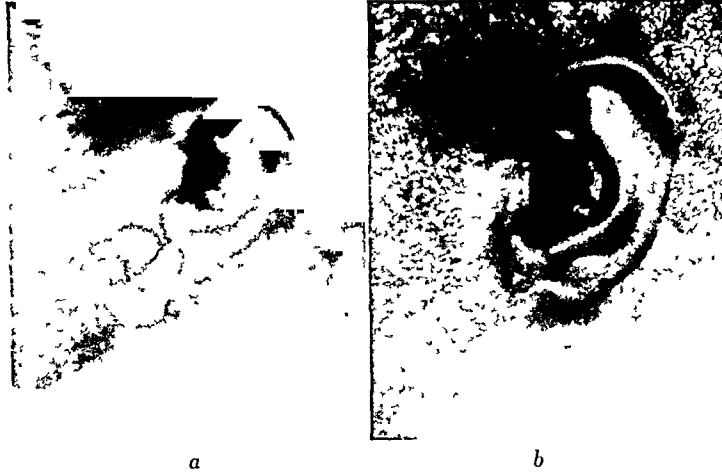


FIG. 5. Photographs of a soldier, aged twenty-five, who was admitted to the Hospital on January 5, 1943, with a large painful keloid growth of the left ear lobe, angle of the jaw and neck (a) interfering with utilization of his helmet strap, which originated when he ran into a barbed wire fence in 1929 snagging the lower part of the ear. The keloid was removed surgically in 1938 but it recurred and was again removed on January 6, 1943. This was followed by two prophylactic doses of x-ray (by Major F. W. Wiklund) consisting of two treatments at five-day intervals of 260 R. units each, a total of 520 R. units at 100 K.V., 4 M.A. through 1.5 mm. aluminum filtration, and (b) is the appearance on the ninth post-operative day. A follow-up twenty-eight months later reveals that no proliferation has occurred to date.

the chest. The pedicle outlined is undercut then resutured into its bed, and while the split thickness graft is taking behind the ear flap, the neck flap is developing its own blood supply. When the tissues are ready, this being determined by texture, appearance and blood supply, the formerly elevated neck flap is again elevated in the subsequent stage suturing the distal end of the flap to the region of the spina helix superior to the external auditory meatus and the remainder of the flap is sutured about the cartilage supported mastoid flap to form the helix. At this time a split thickness graft is placed in the former bed of the flap. (Fig. 3b.) The proximal end of the flap is left attached until such a time that the helix has healed (usually twenty-one days) following which it is detached and the lobule of the ear formed. Occasionally, it is necessary to make minor

minor contours of the pinna are quite variable in different individuals hence it is more important to concentrate on the size and proper angle of the ear rather than reproductions of these contours.

It may be mentioned that some individuals prefer to construct an entire ear on the arm and at a later date transfer the formed ear by a tubed pedicle to its final site on the head, but this does not appeal to us due to the uniformly good results obtained by the method described above.

Padgett gives a description of total reconstruction of the auricle in three similar major procedures with the exception that he makes a large cervical flap and splits it distally, taking the wider anterior part to cover the posterior cartilage graft then transplanting the lower end of the pedicle flap to the upper end of the ear flap and later the end of the tubed pedicle is reversed

and forms the lobule of the ear; subsequent trimming and reshaping is necessary.

Fitch, years ago, reported a case in a young man whose ear was completely severed from his head at which time it was immediately picked up and brought to the doctor's office where it was cleansed and sutured into place, healing perfectly. This is the only report with which I am familiar giving such a result. Such has not been our experience where we have seen or heard of such cases; and since results are so uniformly bad in attempting such a procedure, it would be much more advisable to save the cartilage of the detached ear for future reconstruction by suturing it into a subcutaneous pocket in the abdominal wall until prepared to place it in its proper location.

Another problem which frequently looms up is that of traumatic laceration of the external ear. When the wound is simple, single or linear in character accurate approximation of the skin with No. 000 Corticelli silk gives excellent results; but where the wound is multiple and jagged, one should make every effort to preserve the cartilage of the lacerated area. The question of suturing the cartilage is arbitrary, although most do not; if the surgeon elects to suture it, he should use the very finest silk available, at least No. 000, and in the white shade in order that it will not be visible through the skin. (Figs. 4 and 5.)

Bulbulian has described an improved technic for prosthetic restoration of facial defects by the use of latex compounds; but although there are conditions in which this method may be of advantage such as in advanced age, or as a temporary economic measure before reconstruction is accom-

plished, it does not affect individuals of this age group or status to a great extent.

#### CONCLUSION

There is an abundance of literature on ear reconstruction all of which strike the same defeatist and discouraging note, but I am of the opinion that a high percentage of successful ear reconstruction can be performed with intelligent planning, keeping in mind the necessary requirements and the various methods by which they may be attained. At times it taxes one's ingenuity and imagination but with the continued development of operative skill it can be accomplished.

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# GALLBLADDER SURGERY

## A FIVE-YEAR SURVEY

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A SURVEY has been made of 212 patients operated upon at the Norwegian Hospital, from January 1, 1939, up to and including December 31, 1943. In this survey certain points of interest are found and will be discussed in this paper:

was a female age fifteen who had gallstones. The oldest patient was a female age seventy-four years, also with gallstones. Most of the patients having stones were females between the ages of thirty-five and fifty-five. (Table II.)

*Nationality.* Gallstones occurred most

- Types of Surgery {
- Gallbladder {
    - Primary Gallbladder Surgery
    - Secondary Gallbladder Surgery
      - (1) Cholecystotomy-carcinoma of stomach, liver, pancreas, Abdominal carcinomatosis. 1 case
      - (2) Cholecyst-duodenostomy-Carcinoma head of pancreas. 1 case
      - (3) Cholecystostomy-acute pancreatitis 2 cases
      - (4) Cholecystostomy-subacute pancreatitis 1 case
      - (5) Cholecyst-jejunostomy and biopsy Metastatic scirrhus carcinoma Liver and pancreas 1 case
      - (6) Cholecystostomy and gastro-enterostomy Neoplasm pancreas and duodenal obstruction 1 case
  - Common Duct
    - (1) Choledochostomy 6 cases
    - (2) Cholecystectomy and choledocholithotomy Transduodenal 1 case
    - (3) Cholecystectomy and Choledochostomy 4 cases
    - (4) Cholecystectomy and Choledochotomy 2 cases

*Sex.* There were about four times as many females as males who had their gallbladders removed. Even those who had the combined operation of cholecystectomy and appendectomy the ratio was 4 to 1. In the cholecystostomies the ratio was about 2 to 1. Females had gallstones about three times more frequently than males. (Table II.)

*Age Incidence.* The youngest person operated upon during this five-year period

frequently in American patients. The Norwegian and Italian races also had frequent cases of gallstones. (Table III.)

*Pathology.* There were 152 patients operated upon in whom gallstones were found and there were 166 patients in whom the gallbladder was studied pathologically. Of these gallbladders four cases were reported normal. One normal gallbladder contained stones. The rest had varying degrees of pathological processes.



TABLE I

Operation	Incision	Cases	Anesthesia	Cases	Female Cases	Male Cases	Stones Cases
Cholecystectomy	Right upper rectus	95	General	36	97	26	92
	Right upper mid rectus	7	Spinal	41			
	Right upper paramedial	11	Spinal (pontocain)	31			
	Transverse	2	Spinal (serial)	15			
	Bevain upper rectus	1					
	Mayo Robson	5					
	Oblique subcostal	2					
Cholecystectomy and appendectomy	Right upper rectus	36	General	15	33	9	29
	Right mid rectus	4	Spinal	13			
	Mayo Robson	1	Spinal (pontocain)	14			
	Right upper paramedial	1					
Cholecystectomy and choledochostomy	Right upper rectus	4	General	2	2	2	3
			Spinal	1			
			Spinal (pontocain)	1			
Cholecystectomy and choledochotomy	Right upper rectus	2	Spinal (pontocain)	2	2	..	2
Cholecystostomy	Right upper rectus	5	Local	1	3	2	4
			Spinal	3			
			Spinal (pontocain)	1			
Cholecystostomy and appendectomy	Right upper rectus	1	General	1	..	1	
Cholecystostomy	Right upper rectus	16	General	8	14	7	14
	Transverse	2	Spinal	4			
	Right upper paramedial	3	Spinal (pontocain)	4			
			Spinal (serial)	4			
			Local	1			
Cholecystectomy, choledocholithotomy, transduodenal	Oblique subcostal	1	General	1	1	..	1
Cholecystostomy and gastro-enterostomy	Right upper rectus	1	General	1	1		
Cholecyst-jejunostomy	Right upper rectus	1	Spinal	1	..	1	
Cholecystostomy and cholecyst-jejunostomy	Right upper rectus	1	General	1	..	1	
Cholecystectomy and posterior gastrojejunostomy	Right upper rectus	1	Spinal (pontocain)	1	..	1	1
Cholecystectomy gastrojejunostomy jejunostomy	Right upper rectus	1	Spinal (pontocain)	1	1		
Choledochostomy	Right upper rectus	4	General	1	3	3	3
	Right upper oblique	1	Spinal (pontocain)	2			
	Oblique subcostal	1	Spinal (serial)	2			
			Local	1			
Cholecystectomy, appendectomy, intestinal resection, jejunostomy	Right upper rectus	1	General	1	..	1	1
Gallbladder anastomosis to duodenum	Right upper rectus	1	Spinal (pontocain)	1	1	..	1

TABLE II  
AGES AND GALLSTONES

Ages	Males		Females	
	No Stones	Stones	No Stones	Stones
15	..	..	..	1
16				
17				
18				
19	..	..	1	
20				
21				
22	..	..	2	
23				
24	..	..	..	3
25	..	..	1	1
26	1			
27				
28	..	..	1	3
29	..	..	1	4
30	..	..	1	4
31	..	..	1	
32	1	..	..	4
33	2	..	..	1
34	..	..	2	1
35	..	..	3	3
36	..	2	1	4
37	..	..	..	3
38	..	3	1	1
39	..	1	..	6
40	1	1	1	5
41	1	1	2	
42	..	1	3	3
43	..	..	..	8
44	..	1	2	5
45	1	1	..	5
46	1	4	2	2
47	..	2	2	2
48	..	3	1	2
49	1	1	2	4
50	..	..	1	4
51	..	1	2	
52	2	2	..	3
53	1	2	..	6
54	1	..	..	5
55	..	..	1	2
56	..	1	1	1
57	1	1	..	4
58	1	2	1	3
59	..	1	..	1
60	1	1	1	1
61	1	1	..	1
62	..	..	..	1
63	2	2	..	1
64	1	1	..	1
65	..	..	..	2
66				
67	..	..	1	
68	..	..	..	1
69	..	..	..	1
70				
71	1			
72				
73	1	..	..	1
74	..	..	..	1
75				

TABLE III  
NATIONALITY

	No. of Cases
United States.....	75
Norway.....	36
Italy.....	19
Sweden.....	5
Germany.....	4
Poland.....	3
Austria.....	1
Canada.....	1
Denmark.....	1
England.....	1
Finland.....	1
Hebrew.....	1
Ireland.....	1
Porto Rico.....	1
Scotland.....	1
Syria.....	1

TABLE IV  
PATHOLOGY  
A

Pathological Diagnosis	No Stones Cases	Stones Cases
Normal gallbladder.....	3	1
Cholecystitis.....	4	18
Acute cholecystitis.....	5	24
Subacute cholecystitis.....	1	
Chronic cholecystitis.....	15	36
Chronic productive cholecystitis.....	5	13
Cholecystitis with atrophy mucosa....	..	1
Acute proliferative cholecystitis.....	..	2
Acute suppurative cholecystitis.....	1	2
Acute necrotic cholecystitis.....	1	2
Necrotic cholecystitis.....	..	4
Cholecystitis glandularis.....	2	3
Chronic cholecystitis glandularis.....	..	1
Fibrous cholecystitis.....	..	1
Catarrhal cholecystitis.....	..	3
Fibrotic productive cholecystitis.....	..	1
Recurrent cholecystitis.....	..	2
Recurrent cholecystitis glandularis...	..	1
Cholecystitis glandularis proliferans..	2	2
Productive cholecystitis.....	..	9
Mechanical cholecystitis.....	2	1
Strawberry cholecystitis.....	1	
Acute cholecystitis on chronic produc- tive cholecystitis.....	..	1

## B

## Perforations of Gallbladder

- (1) Perforation into abdominal cavity..... 2 cases  
 (2) Pericholecystic abscess.....  
 (3) Perforation into another viscus (into the  
 duodenum)..... 1 case

There were three pathological perforations. Two were into the abdominal cavity and one into the duodenum. (Table iv.)

TABLE V  
SYMPTOMS

Symptoms	Gallstones Cases	Gallstones with Gallbladder Disease		Gallbladder Disease No Gallstones	
		Acute Cases	Chronic Cases	Acute Cases	Chronic Cases
Pain right upper quadrant	1	23	42	6	10
Pain right upper quadrant radiating to right shoulder	2	6	16	1	5
Pain right upper quadrant radiating to right scapula		9	27		7
Vomiting		21	46	7	15
Nausea	1	17	35	5	16
Gas belching	2	11	22		6
Unable to tolerate fats		5	16		4
Unable to tolerate fried foods			4	1	1
Unable to tolerate eggs			1		
Bloated feeling		4	9		3
Heart burn			6		1
Sour eructations	1	1	5		2
Flatulence			5		1
Constipation			1		
Diarrhea			1		
Indigestion	1		1		
Anorexia		1	2		
Loss of weight			2		1
Chilly feeling		3			
Feverish feeling		3			
Sweats		1			

TABLE VI  
PHYSICAL EXAMINATIONS

Physical Signs	Gallstones Cases	Gallstones with Gallbladder Disease		Gallbladder Disease No Gallstones	
		Acute Cases	Chronic Cases	Acute Cases	Chronic Cases
Tenderness (right upper quadrant)	3	37	74	6	28
Obesity	3	24	55	4	18
Rebound tenderness (right upper quadrant)		2	6		1
abdominal rigidity (right upper quadrant)	1	7	9	1	3
Palpable mass (right upper quadrant)		4	14		2
Jaundice	1	3	18	1	2

*Symptoms.* An analysis of symptoms was made only on those cases which were studied pathologically. There were five patients without pain; all the others had

pain. Nausea, vomiting, and gas belching were also outstanding symptoms. Some of the other symptoms present were sense of

TABLE VII  
BLOOD COUNTS

White Counts	Gallstones	Gallstones with Gallbladder Disease		Gallbladder Disease No Gallstones	
		Poly Counts	Acute Poly Counts	Chronic Poly Counts	Acute Poly Counts
4,001-4,500			40		54
4,501-5,000			54, 74		
5,001-5,500			52, 72, 75		
5,501-6,000			51, 68		
6,001-6,500			52, 52, 56, 72, 78, 85		55
6,501-7,000	74	55	55, 65, 78, 82, 85		62, 81
7,001-7,500		72	68, 82, 86	55	70, 84
7,501-8,000	71	63, 67, 81	54, 56, 61, 61, 62, 65, 69, 70, 71, 74, 78		52, 58, 67, 71, 76
8,001-8,500			57, 60, 61, 61, 63, 65, 74, 76	78	64, 68, 77
8,501-9,000	71	54	56, 64, 70, 71, 72, 73, 76, 79, 84	58	52, 61
9,001-9,500			54, 58, 68, 68, 71, 85		66, 76, 77
9,501-10,000	57	58, 63, 77, 80	60, 73, 85	76	82, 88
10,001-10,500			51, 79, 80, 82, 87, 90		61, 97
10,501-11,000			61, 70, 75, 81, 84		64, 76, 82
11,001-11,500			69, 79, 87, 88		
11,501-12,000			76, 80		86
12,001-12,500			68, 71, 90		64
12,501-13,000			74, 75, 82, 89, 89		
13,001-13,500			71, 78, 83, 86, 86, 89	94	
13,501-14,000		74	44		60, 77
14,001-14,500		89	76, 77	89	
14,501-15,000					
15,001-15,500		77, 78, 86	83		82
15,501-16,000		84		84	
16,001-16,500					
16,501-17,000		95			
17,001-17,500					
17,501-18,000					
18,001-18,500		80			
18,501-19,000					
19,001-19,500					
19,501-20,000					89
20,001-20,500					
20,501-21,000				89	
21,001-21,500					
21,501-22,000					
22,001-22,500					
22,501-23,000			88		
23,001-23,500		92			
26,000		92			

bloating after meals, heart burn, and sour eructation. Many patients gave a history of being unable to eat fatty and fried foods. (Table v.)

*Physical Examination.* Tenderness in the right upper quadrant was present in

and 170 mg. per 100 cc. of blood. Most of the readings were between 125 and

TABLE VIII  
VAN DEN BERGH TEST

	Result	Icteric Index	Pathological Process
1	Negative	6 2	Gallstones
2	Negative	6 6	Gallstones
3	Negative	8 2	Gallstones
4	Negative	13 0	Gallstones
5	Negative	15 0	No gallstones
6	Negative	18 7	Gallstones
7	Biphasic reaction	15 0	Carcinoma of liver
8	Biphasic reaction	18 1	Gallstones
9	Delayed reaction	12 5	Gallstones
10	Delayed reaction	25 0	Gallstones
11	Immediate direct reaction	?	No gallstones
12	Immediate direct reaction	24 2	Gallstones
13	Immediate direct reaction	30 0	Gallstones
14	Immediate direct reaction	30 0	Gallstones
15	Immediate direct reaction	37 0	Carcinoma of liver and stomach
16	Immediate direct reaction	50 0	Gallstones
17	Immediate direct reaction	78 9	Gallstones

87 per cent of the cases. Rebound tenderness and rigidity were also noted in some of the patients. Palpable masses in the right upper quadrant were noted in about 12 per cent of the patients. Fifty-nine per cent of the patients were obese and 14 per cent were jaundiced. (Table vi.)

*Laboratory.* The blood counts presented are those taken on admission. They are very variable and are not of much value in the diagnosis of gallbladder disease either with or without gallstones, or whether the gallbladder condition is acute or chronic. (Table vii.)

Urine examinations were done routinely on all admissions. Those patients who were jaundiced showed bile in the urine.

The stools were examined in nine cases for bile in jaundiced patients. They were positive in seven cases.

Blood cholesterol was taken in twelve patients. The readings were between 99

TABLE IX  
SEDIMENTATION TIME

	Pathological Process	Results
1	Cholecystitis with cholelithiasis	35 min.
2	Cholecystitis with cholelithiasis	1 hr.
3	Cholecystitis with cholelithiasis	2 hr. and 40 min.
4	Acute cholecystitis with stones	12 min.
5	Acute cholecystitis	19 min.
6	Acute cholecystitis	35 min.
7	Acute cholecystitis with cholelithiasis	35 min.
8	Acute cholecystitis	40 min.
9	Acute cholecystitis	2 hr. and 35 min.
10	Acute suppurative cholecystitis with cholelithiasis	23 min.
11	Acute necrosis of gallbladder	80 min.
12	Chronic cholecystitis with cholelithiasis	20 min.
13	Chronic cholecystitis with cholelithiasis	3 hr. and 18 min.

150 mg. per 100 cc. In all these cases the gallbladders were diseased.

Blood chlorides were taken in twenty-three patients. In about 50 per cent of the cases the readings were low. In one case it was as low as 300 mg. per 100 cc. of blood.

The icteric index was taken in twenty-five patients. It was normal in three patients while the rest were increased. In one case it was as high as 64.2.

The Van den Bergh test was performed upon seventeen patients. (Table viii.)

The bleeding time was taken in one case in which the icteric index was 78.2.

The coagulation time was taken in four patients. The readings were 2½ minutes with icteric index of 22.8, 5 minutes with icteric index of 6.2, and two cases of 4½ minutes and 8½ minutes with no icteric index readings recorded.

The prothrombin time was taken on one patient with a reading of one hour.

The sedimentation time was taken on thirteen patients. (Table ix.)

The hematocrit determination was taken on thirty patients. It was first taken October 18, 1940. The hematocrit cell X-rays were taken in eighty-two cases preoperatively. Gallstones were reported visible in twenty-seven cases while dis-

TABLE X  
HOSPITALIZATION

Operation	Days	Cases	Days	Cases	Days	Cases
1. Cholecystectomy	12	1	22	7	32	2
	13	2	23	3	33	1
	14	18	24	6	34	1
	15	8	25	..	35	1
	16	11	26	4	48	2
	17	7	27	1	51	1
	18	11	28	1	64	1
	19	9	29	1	73	1
	20	7	30	2	75	1
	21	6	31	2		
2. Cholecystectomy and appendectomy	13	1	19	2	25	1
	14	6	20	..	30	1
	15	5	21	3	39	1
	16	6	22	2	53	1
	17	4	23	2	65	1
	18	3	24	2		
3. Cholecystostomy	20	1	26	1	32	1
	21	2	27	.	35	1
	22	2	28	1	40	2
	23	.	29	1	41	1
	24	1	30	2	48	1
	25	1	31	..	84	1
4. Cholecystostomy and appendectomy	20	1				
5. Cholecystotomy	24	1				
	26	1				
	56	1				
6. Choledochostomy	14	2	19	1	36	1
	17	1	31	1		
7. Choledochostomy and cholecystectomy	20	3				
	46	1				
8. Choledochotomy and cholecystectomy	26	1				
	31	1				
9. Cholecystostomy and gastro-enterostomy			24	1		
10. Cholecystectomy and choledolithotomy			28	1		
11. Cholecystostomy and cholecyst-jejunostomy			62	1		
12. Gallbladder anastomosis to duodenum			25	1		
13. Cholecystectomy and posterior gastrojejunostomy			16	1		
14. Cholecystectomy and gastrojejunostomy			105	1		
15. Cholecystectomy, appendectomy, jejunostomy, intestinal resection			107	1		

determinations ranged between 39 and 89 per cent. Eleven cases were over 50 per cent. The plasma proteins were all over five.

The total proteins with albumin-globulin ratio was performed on ten patients. In five cases the albumin was below four, while the total protein in each of these cases was below six.

eased gallbladders were reported in thirty-eight cases. Both gallstones and diseased gallbladders were reported in nine cases. Two x-ray reports were negative for gallstones. Six patients were x-rayed prior to admission but the reports were not available.

*Hospitalization.* Patients who had cholecystectomies either alone or with appen-

dectomies were hospitalized from fourteen to twenty-four days. The patients who had cholecystostomies and choledochos-

subserously. In eleven cases it was impossible to isolate the cystic artery and duct and the stump was tied off in

TABLE XI  
PREOPERATIVE HOSPITALIZATION FOR ACUTE  
CHOLECYSTITIS (CLINICAL)

Time, Hrs.	No. of Cases	Time, Days	No. of Cases
1	3	1	
2	..	2	3
3	3	3	2
4	2	4	3
5	1	5	2
6	1	6	1
7	..	7	4
8	3	8	2
9	2	9	2
10	3	10	
11	2	11	1
12	3	12	
13	1	13	1
14	1	14	
15	3	15	1
16	1	16	
17	2	17	1
18	1		
19	4		
20	1		
21	1		
22	1		
23			

tomies were hospitalized for a longer period of time. (Table x.)

There were sixty-two patients admitted with a clinical diagnosis of acute cholecystitis with or without stones and of these 63 per cent were operated upon within twenty-four hours. (Table x1.)

*Type of Incision.* The upper right rectus incision was the most popular during this period of time. It was used in 80 per cent of the cases. The upper right paramedial incision was used in 7 per cent of the cases. (Table x11.)

*Procedures.* Removal of the gallbladder from above down was the more popular choice. This method was used in 71 per cent of the cases. In two patients the gallbladder was split before being removed. Fifteen cases were aspirated prior to removal. Three gallbladders were removed

TABLE XII  
TYPES OF INCISION

	No. of Cases
Right upper rectus incision.....	170
Right upper paramedial incision....	15
Right upper mid-rectus incision.....	11
Upper oblique incision.....	1
Oblique subcostal incision.....	4
Transverse incision.....	4
Mayo Robson incision.....	6
Bevain (right upper rectus) incision.	1

one mass. Peritonization of the liver bed was performed in forty-six cases of cholecystectomies.

*Drainage in Cholecystectomy.* Cigarette and iodoform drains were the types of drains used. The cigarette drain was used as a routine while the iodoform drain was used in cases in which there was bleeding. There was no drainage in thirteen cases of cholecystectomies. Drainage in cholecystectomies was usually from four to eleven days. In cholecystostomies rubber tubes and catheters were used and the length of time varied from nine to nineteen days. In draining the common duct a T-tube was used in all cases and here, too, the time varied from eight to fourteen days. (Table x111.)

*Anesthesia.* General anesthesia was the more preferable anesthetic at the beginning of the period of this survey. Then spinal anesthesia began to replace general anesthesia. Pontocain was first combined with novocain for spinal anesthesia on January 4, 1940, for biliary surgery. Then serial spinal anesthesia was introduced on March 18, 1942, and it is at present the anesthetic of choice when spinal anesthesia is not contraindicated. (Tables I, xiv and xv.)

*Complications.* Besides dehydration, distention, and shock, atelectasis was noted in eight cases. Four cases were on the right side and four were on the left side. Pneumonia was also noted in some of the patients. It was broncho in character in five patients and lobar in one. Eight

TABLE XIII  
DURATION OF DRAINAGE

Operation	Type of Material	Days																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Cholecystectomy	Cigarette			4	20	33	24	25	25	8	10	8	3	1	1		2	
		Days																
		18	19	20	21	22	23	24	?									
			1	1					13									
		Days																
		7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	?	
Cholecystostomy	1. Pezzar #28 Catheter	1														1	2	
	2. Tube (rubber)			2	2	1			1	1	1	1		1			2	
	3 Catheter								1						1			
	4. Catheter #16													1				
	5. Catheter #20																1	
Choledochostomy	T tube			1				1									4	
Cholecystectomy and choledochostomy	T Tube		1			1			1								1	

TABLE XIV  
ANESTHESIA

Date	General Cases	Spinal Novocain Cases	Spinal Novocain and Pontocain Cases	Spinal Serial Cases	Local Cases
Jan 1, 1939 to June 30, 1939	15	10			
July 1, 1939 to Dec 31, 1939	12	12			
Jan 1, 1940 to June 30, 1940	8	9	6		
July 1, 1940 to Dec 31, 1940	9	1	5		
Jan 1, 1941 to June 30, 1941	13	8	17		
July 1, 1941 to Dec 31, 1941	3	4	6		1
Jan 1, 1942 to June 30, 1942	2	3	6	2	
July 1, 1942 to Dec 31, 1942	2	5	11	5	1
Jan 1, 1943 to June 30, 1943	2	5	2	6	1
July 1, 1943 to Dec 31, 1943	2	6	5	7	

other cases were not labeled as to type. There were fourteen cases in all. One patient developed bilateral empyema and four patients expired. Cardiac complications were also occasionally seen. (Table XVI.)

**Mortality.** The mortality rate was 6 per cent. Pneumonia and cardiac failures were the more frequent causes of death. Paralytic ileus was also noted as a cause of death in several patients. (Table XVII.)

**Prophylaxis.** There are numerous procedures and drugs used at present to prevent complications and to take care of them when they arise. At the Norwegian Hospital it is a routine procedure to give carbogen immediately after gallbladder surgery ten minutes every hour for the

first twenty-four hours, to have the patient flat in bed for four to six hours and then the patient is dehydrated, fluid is given with glucose both subcutaneously and

TABLE XV  
SPINAL ANESTHESIA

Agent	Amount Used in Mg.															
	10	13	15	18	20	75	100	120	150	175	200	225	235	250	275	300
A. Novocain (cases)	..	..	..	..	..	..	1	..	2	1	33	1	1	2	1	9
B. Novocain and Pontocain (cases)	..	..	..	..	..	1	53	1	2							
	1	2	7	6	41											
C. Novocain (Serial) (22 cases)	Mg.					Mg.					Mg.					
	88					200					334					
	120					200					350					
	130					200					360					
	140					200					450					
	150					210					450					
	150					220					460					
	150					220										
	180					325										

to have the patient with a low back rest. Deep breathing is also encouraged and

TABLE XVI  
COMPLICATIONS

1. Abscess, right subphrenic, 1 case
2. Acidosis
3. Atelectasis, 8 cases
4. Cystitis, acute, 1 case
5. Dehydration
6. Distention
7. Embolism, cerebral, 1 case
8. Fistula, biliary, 1 case
9. Heart,
  - a. Acute cardiac decompensation, 1 case
  - b. Coronary spasm, 1 case
  - c. Toxic myocarditis, 1 case
10. Hemorrhage, cystic artery, 1 case
11. Hyperpyrexia, cause unknown
12. Infection, wounds
13. Intestinal obstruction, 1 case
14. Liver toxemia, 1 case
15. Paralytic ileus, 2 cases
16. Peritonitis, 2 cases
17. Pneumonia
  - a. Bronchopneumonia, 5 cases
  - b. Lobar pneumonia, 1 case
  - c. Postoperative pneumonia, 8 cases
18. Shock

frequent change of position. These help to prevent pulmonary complications. If

parenterally. This also overcomes acidosis. Whole blood is given if the red blood cells or hemoglobin content is low. Chlorides are given if the blood chlorides are low. Amino acids are given orally and parenterally if the blood proteins are low. If shock is present, plasma is given and also adrenal extracts such as eschatin. Calcium gluconate and vitamin K also are given both preoperatively and postoperatively to prevent bleeding. Vitamin K was used in thirty-two patients in this series. Sulfa drugs such as sulfanilamide or sulfathiazole are used both directly into the wound to prevent infection and if necessary orally or intravenously for the relief of hyperpyrexia. Of course, frequent blood levels of the sulfa drugs as well as urine examinations and red blood cell counts and hemoglobin determinations are made during the administration of the drugs. Iron and vitamins also are used when indicated. Prompt surgery on primary acute cholecystitis is also performed when possible while the patient's condition is still good



TABLE XVII  
MORTALITY

	Age	Sex	Nation	Pathological Diagnosis	Days P.O.	Anesthesia	Cause of Death	Operation
1	37	F.	U.S.	Acute cholecystitis and cholelithiasis	1½	Spinal	Liver toxemia	Cholecystectomy
2	38	F.	Norwegian	Chronic cholecystitis and cholelithiasis	13	General	Bilateral bronchopneumonia	Cholecystectomy
3	45	F.	Poland	Cholecystitis and cholelithiasis	2	Spinal	Congestion right base, acute cardiac dilatation	Cholecystectomy
4	49	M.	Finland	Metastatic scirrhus carcinoma	49	Spinal	Carcinoma pancreas, liver, and lungs	Cholecystjejunostomy
5	51	F.	U.S.	Chronic cholecystitis	6	Spinal	Paralytic ileus, chronic hepatitis	Cholecystectomy
6	52	F.	Denmark	Acute cholecystitis, cholelithiasis, recurrent appendicitis	4	Spinal	Peritonitis, paralytic ileus	Cholecystectomy, appendectomy
7	58	M.	Italy	Acute cholecystitis	8	Spinal	Myocardial failure	Cholecystectomy
8	60	F.	Italy	Gallstones	2	Spinal	Acute pulmonary edema, cardiac dilatation	Cholecystotomy
9	61	M.	U.S.	Metastatic adenocarcinoma	13	Spinal	Adenocarcinoma stomach, liver, pancreas	Cholecystotomy
10	64	M.	Sweden	No stones, acute cholecystitis (clin.)	12	Local	Cerebral embolism	Cholecystostomy
11	65	F.	Norwegian	Gallstones	3	General	Postoperative pneumonia, acute cardiac decompensation	Cholecystostomy
12	67	F.	U.S.	Gallbladder normal, chronic atrophic appendicitis	5	General	Postoperative lobar pneumonia	Cholecystectomy, appendectomy
13	73	M.	Finland	Chronic cholecystitis	13	Spinal	Pulmonary edema myocardial failure	Cholecystectomy

and there are no complications which often follow such an attack.

#### CONCLUSIONS

1. There was quite a variety of gallbladder surgery performed during this five-year period.

2. Females were more prone to gallbladder disease than males.

3. Certain laboratory data are important for the more intelligent treatment of patients with gallbladder disorders.

4. Hospitalization varied from fourteen to twenty-four days.

5. Patients with primary acute cholecystitis were often operated upon as soon as arrangements were made.

6. The upper right rectus incision was the more popular one.

7. Removal of the gallbladder from below up was the method of choice. Aspiration of the gallbladder was often performed to facilitate surgery. Isolation and separate ligation of the cystic duct and cystic artery were attempted when possible. Peritonization also was performed when feasible.

8. Most of the cholecystectomies were drained.

9. Spinal anesthesia was the anesthetic of choice.

10. Pulmonary, cardiac, and paralytic ileus were the more frequent complications seen.

11. The mortality rate was 6 per cent.

12. Certain procedures and drugs are advocated for both prophylactic and therapeutic uses.

# PERIRENAL INSUFFLATION\*

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WITH the advent of the cystoscope and retrograde and intravenous urography, urology has come to enjoy the reputation of being one of the most diagnostically accurate of the medical specialties. The addition of perirenal insufflation to our diagnostic armamentarium has been a very valuable advance and a distinct asset. The ability to introduce air or gases into the perirenal space permitting a clearer visualization of the outline of the kidney, adrenal glands and other retroperitoneal structures is not new. As is well known, Carelli, in 1921, first described this procedure and told of his experiences with it. Mainly, because of difficulties with technic and also our failure to crystallize certain definite opinions as to its value, this method failed to enjoy the ready use which it should have had. After a lapse of almost fifteen years, during which little was heard of it, Cahill reported on its value in certain types of retroperitoneal lesions and he, along with others, published their experiences with perirenal air injections, all emphasizing its importance as a valuable aid in the differential diagnosis between adrenal and pararenal tumors.

In spite of reports to the contrary, it is our impression that with a thorough knowledge of the anatomy of this region and with some application, one ought not to encounter any difficulty in mastering the technic, and particularly the urologist should feel quite at home and familiar in its use.

It is true that the modern radiographic technic and equipment permit us to obtain a distinctly visible kidney contour and mass density in most instances. Yet, there

have been, in our experience, cases in which, because of overlying malpositioned organs, pocketed intestinal gas and contents or perirenal adhesions and perinephritis, the kidney borders are not clearly discernible. In these instances, perirenal air injections are of definite value. Because of this, we have of late resorted to the use of this procedure with increasing frequency, with and without pyelography or urography.

By surrounding the kidney with an envelope of air, we have obtained valuable added information in unusual cases of ptosis, rotations or failure of rotations, malformation, agenesis or atrophy of the kidney. Further, the ability of air to surround the kidney completely, the seat of a neoplastic process, is excellent evidence that the malignant growth has not broken through the capsule and invaded the perirenal tissues. This indicates, as has been shown by others, that the renal mass is movable and, therefore, more favorably operable. In addition, in certain cases of hydronephrosis or pyonephrosis in which dye tests have indicated an absence of function, the combined use of perirenal air insufflation and pyelography offers a very excellent method of estimating the amount of parenchymal and structural damage. Sufficient information can be obtained in this manner at times to justify a conservative handling of the case rather than a nephrectomy. We feel justified, therefore, in suggesting a more free and wider use of this diagnostic procedure in urology.

Since its introduction by Carelli, and his description of his technic, a number of modifications have been proposed, and

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published by many with little or no alterations in the site and manner of making the puncture. The suggested use of the pneu-

with a built in water manometer. A two-way stop-cock connects the machine to the manometer or to the patient. (2) A

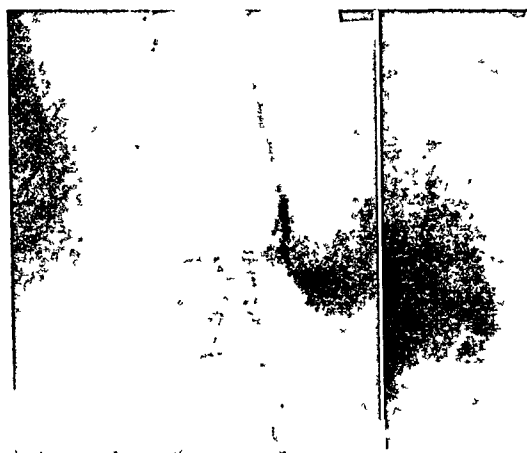


FIG. 1.

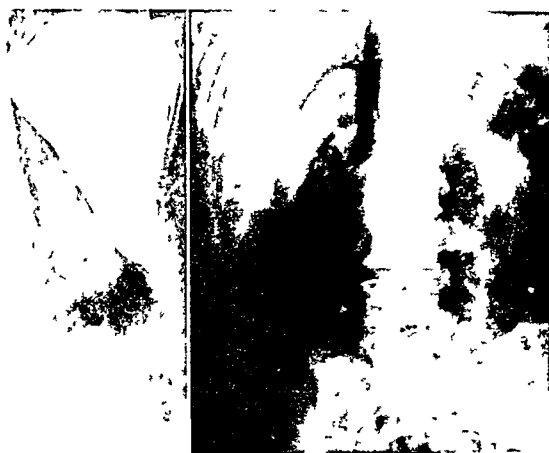


FIG. 2

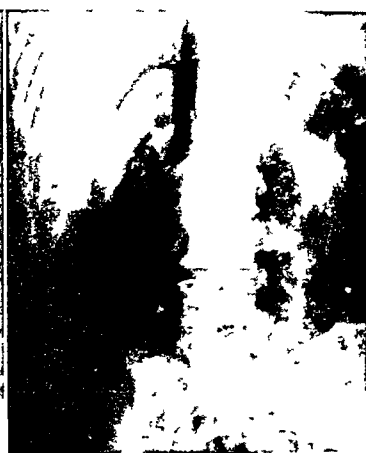


FIG. 3

FIGS. 1, 2, AND 3. Perirenal air injections in normal cases. The kidney outline is clearly visible. In Figure 2 the adrenal gland is nicely outlined and in Figure 3 the vascular renal pedicle is noted.

mothorax apparatus for the introduction of the gaseous element or air has been an important addition to the technic and a definite safeguard. The technic employed by us is not new or original but is a combination of all the safer elements of the various suggested procedures. Our results have been singularly devoid of any untoward reactions and uniformly good. Following the suggestion of W. H. Mencher, in every case in which insufflation is contemplated, retrograde or intravenous pyelography is performed previous to the injection so as to obtain essential data as to the size, position and as much of the outline of the kidney as is possible. For as he states, in renal rotations, the vascular pedicle might be in the path of the needle puncture or if the tumor is large, the needle might be plunged directly into its mass. This is a most necessary precautionary measure in the prevention of air embolization. In addition to this a routine chest plate is taken.

#### TECHNIC

*Equipment.* In performing this procedure, the following equipment is necessary: (1) A standard pneumothorax apparatus

spinal tap needle, 18 or 20 gauge; (3) rubber tubing, one end of which fits into the spinal needle and the other, into the pneumothorax outlet; (4) syringe and needle for local novocaine infiltration, and (5) sterile drapes and skin sterilizing medium.

*Preparation.* The patient is prepared as for any surgical procedure receiving a cathartic the preceding night, a soap suds enema the next morning, all fluids and food are withheld until after the preliminary x-rays are taken, and usually, one or two doses of prostigmine are given, along with a rectal tube, two hours and one hour before the injection is made. On call, the patient is given  $\frac{1}{4}$  gr. of morphine or any other sedative.

*Procedure.* In selecting the site of injection, it is borne in mind that the renal fascia forms a cone-shaped compartment around the kidney and adrenal gland and extends from the diaphragm down into the pelvis. The air can, therefore, be injected at multiple sites depending on the particular case. Accordingly, the patient is placed on the side, and as in preparation for kidney surgery, the supra-iliac space is made prominent by a roll or brace under the opposite supra-iliac space. The outer

edge of the erector spinae muscle is palpated at the level of the second lumbar vertebra, and this spot is infiltrated with novocaine deep into the subcutaneous tissues and muscles. Some writers have suggested the selecting of the site of injection by palpating the twelfth rib in the axillary line and from this point, a line is drawn vertically downward meeting the lateral margin of the erector spinae muscles. Depending upon the location of the suspected disorder, the site of injection should be closer to the sacrum if the lesion is in the upper pole of the kidney, and opposite the first lumbar vertebra, if the lesion is in the lower pole, without deviating from the lateral border of the erector spinae muscles as a landmark. Still others have suggested the utilization of the posterior one-fourth of the routine lumbar kidney incision as the site of injection.

Having selected the proper site and anesthetizing the area, the spinal needle is introduced at right angles, usually pointing slightly caudad and injecting novocaine enroute if desired. In about 50 per cent of the cases a definite sense of perforation is obtained on penetrating the transversalis fascia, and soon thereafter again when piercing the fascia of gerota. The introduction of the needle should be done slowly and carefully so as to avoid penetrating into the renal substance. That this has occurred can be easily detected if upon asking the patient to breathe deeply, the respiratory excursions are transmitted to the distal end of the needle. The simple withdrawal of the needle until these excursions cease is all that is necessary to correct this. A syringe is attached to the needle at this point and careful aspiration will rule out the possibility of the needle having entered a blood vessel. The needle may now be connected to the pneumothorax apparatus and 5 to 10 cc. of air allowed to enter. A successful insertion is accompanied by distinct respiratory oscillation in the manometer, with reading of 4 to 10 cm. on inspiration and 1 to 5 cm. on expiration. The continued introduction

of air never appreciably alters these pressure readings.

Therefore, a successful puncture is iden-



FIG. 4. An opacity overlying the kidney shadow is definitely proved to be extrarenal.

tified by respiratory manometric oscillations of the stated pressure readings without alteration with corresponding increase in volume of air injected. This is so, because the cone of renal fascia, actually outlining a potential space, can accept air which readily diffuses with increase in pressure. Increasing pressure readings, therefore, indicate that the needle is outside of the space, and it should be withdrawn and reinserted. Air is now allowed to enter 50 cc. at the time and with each increment, pressure readings are taken. We wish to emphasize again that respiratory oscillations on the manometer without increasing pressure as air is injected is the only positive proof that the needle lies in the perirenal space and close attention to this will prevent accidents. From 250 cc. to 500 cc. of air may be injected. In our series, the average quantity of air injected has been about 400 cc. Air, oxygen or carbonic acid gas may be injected although oxygen is probably the better of the three. We have used air exclusively and have noted no toxic effects from it. X-rays of the abdomen in the anteroposterior, oblique, and lateral views are taken immediately, and

repeated in twelve hours and twenty-four hours, and at the latter time, the chest is also x-rayed to ascertain the presence of

lumbar region injected. Rarely is this uncomfortable.

In the past five years, we have used

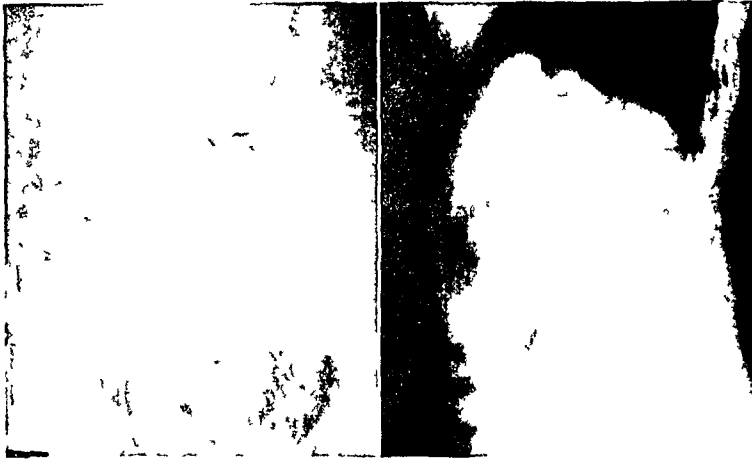


FIG. 5

FIG. 6.

FIGS. 5 AND 6. Crossed, fused renal ectopia. The injected air envelopes the kidneys and demonstrates the point of fusion.



FIG. 7

FIG. 8.

FIGS. 7 AND 8. Pyelonephritic atrophy of the kidney, two cases.

mediastinal air. X-rays may also be taken in the upright position. We advise against bending exercises to assist in the diffusion of the air as suggested by others. We believe this is dangerous and predisposes to air emboli. The rate of absorption of the gases depends on the medium used, for instance, air requires three to five days, oxygen about eighteen to twenty-four hours and carbonic acid gas a longer time. As a rule, the patient notes a slight sensation of fullness and compression over the

perirenal insufflation in 175 cases to great advantage and without complication of note. There were no fatalities. Air was the medium injected in all instances, the average quantity being about 400 cc. In seven cases, both perirenal spaces were deliberately injected simultaneously, without undue effects, each side receiving 300 cc. of air. This is simply recorded as having been done but is not recommended. In about 10 per cent of the cases, in performing air insufflation the air passed to the contra-

lateral perirenal space, and outlined the kidney. This occurrence proves a congenital communication between both perirenal

phenomenon is, therefore, not to be considered an accidental occurrence.

In thirty or 17.5 per cent of the cases

FIG 9.



FIG 10



FIG. 11.



FIG 12.



FIGS. 9 TO 12. Pyelograms and air injections in two cases of renal neoplasm. The suspicion created by the bizarre left pyelogram greatly strengthened by the large kidney shadow outlined by the injected air.

spaces in a small group of cases. The manner in which this can occur is clarified by Congdon and Edson in their discussion of the cone of renal fascia. They state, "A complete connective tissue guiding plan is constituted across the vertebral column in the region of the duodenum, and pancreas from one side to the other, behind which air might pass because of the fact that the anterior fascial layer is continuous with a connective tissue lamina related to the posterior surface of the pancreas on the left side, and on the right, with a connective tissue sheet related to the posterior surface of the duodenum." With these anatomical facts at hand this

pain under the diaphragm and isolateral shoulder was noted. This was usually mild, never distressing and of short duration. The presence of mediastinal air as noted by an x-ray of the chest is always symptomless and occurred in six instances or 3.4 per cent of the cases. One patient developed emphysema of the neck along with mediastinal air. This was an objective finding producing no symptoms. In eight or 4.6 per cent the kidney cortex was pierced by the needle. This complication was indicated by the movement of the distal end of the needle with respiration. This was corrected without ill effects by simply withdrawing the needle until its oscillations

ceased. We are aware of the possibility of the occurrence of a subcapsular hematoma

which air injection was used to advantage in definitely localizing an opacity which lay

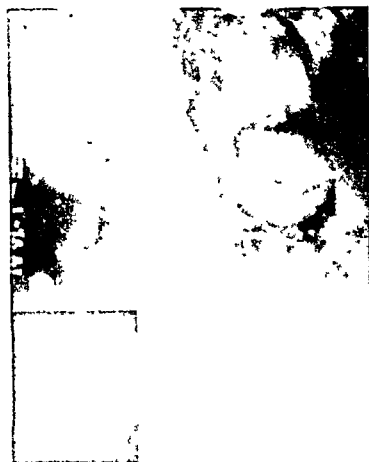


FIG. 13.

FIG. 13. Cystic kidney beautifully outlined by air.



FIG. 14.

FIG. 14. Tremendous adrenal adenoma clearly identified by air injection.

and air emboli in these instances. In one case, an accidental injection of air was made into the colon, fortunately without untoward effect to the patient. In this same individual a successful air injection was done at a later date.

In every instance of the 175 cases in this series there was a definite indication for the use of perirenal insufflation. We have already discussed the indications for drawing on this procedure for diagnostic assistance. We present herewith illustrative cases in which air injections have been of distinct help in clearing away diagnostic doubts.

Figures 1 and 2 are anteroposterior and oblique views, respectively, of a normal case. The kidney outline is clearly discernible surrounded by an envelope of air. One notes the adrenal gland distinctly demarcated as a triangular cap resting upon the upper pole of the kidney. We have found more commonly that the normal adrenal gland is invisible or represented by small, vague, soft tissue shadows. Figure 3 represents a normal case also, and here, one notes that the vascular pedicle is visible, and that air has infiltrated across the midline and outlines the other kidney. Figure 4 illustrates a case in

over the kidney shadow. The perfectly normal pyelogram leads us to suspect that this was not a calculus. The usual roentgenographic tricks including change in position of the patient were of no assistance. The burrowing of air between the kidney and the opacity clearly placed the latter as extrarenal. Figures 5 and 6 are those of a case of crossed, fused renal ectopia. The lower kidney was the seat of a chronic pyelonephritis. The air injection, in lateral view, shows the point of fusion between the lower pole of the upper kidney, and the upper of the lower kidney. Figures 7 and 8 are of two cases of pyelonephritic atrophy of the kidney with hypertension. In both cases the kidney outlines were never visible due to perinephritic changes. The envelope of air demonstrated the actual kidney size. In each instance nephrectomy was performed. Figures 9 to 12 inclusive show pyelograms, and air insufflations in two cases of renal neoplasm. The pyelogram in Figure 9 was bizarre, but not typical of renal tumor. The air injection clearly demonstrated the enlarged renal mass. The air diffused quite completely about the kidney in each case, indicating that local extension of the

malignant process had not occurred. In both instances an easy nephrectomy was

including the great vessels and could not be resected. Although the diagnosis of dermoid

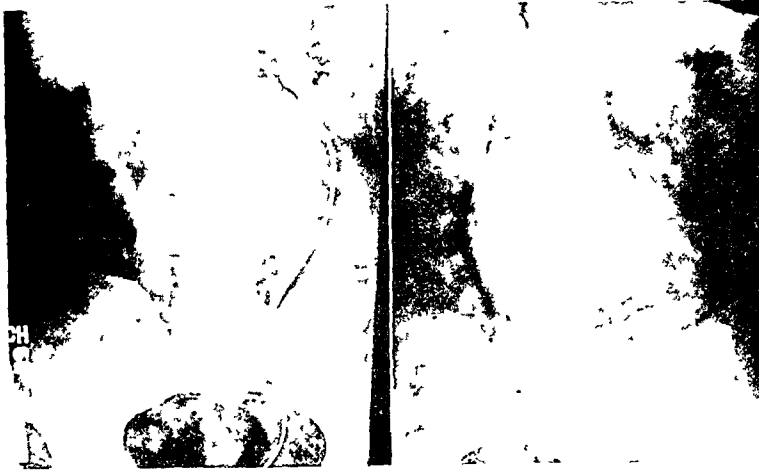


FIG. 15.

FIG. 16.

FIGS. 15 AND 16. Pyelogram and air injection in an unusual case of retroperitoneal dermoid

done for lower pole tumor. Figure 13 is that of a case of cystic kidney. Note how clearly the large upper and lower pole cysts are visible. The insert is a photograph of the nephrectomized kidney. The pyelogram in this case, peculiarly, was originally interpreted as normal. In Figure 14 we have a huge adrenal tumor which had been diagnosed on the basis of typical endocrine symptoms, and a downward displacement of the corresponding kidney upon pyelography. The air injection was done principally for academic reasons, but proved the mass to be well localized, fairly free from surrounding adhesions and distinct from the kidney. This tumor was removed through a flank incision with complete clinic recovery. Figures 15 and 16 are of an unusual retroperitoneal dermoid producing left costovertebral pain and other pressure symptoms. This case has been reported elsewhere. As indicated by the failure of air to envelope the mass completely at the operation, the tumor was found thoroughly adherent to all surrounding structures in-

cluding the great vessels and could not be resected. Although the diagnosis of dermoid

#### SUMMARY

Perirenal air insufflation has proved itself to be of great value in the differential diagnosis of all retroperitoneal lesions in and about the kidney. Its use permits us to draw conclusions concerning the local spread and operability of renal tumors hitherto not possible. The technic is not difficult and can be mastered quite promptly especially by the urologist who is thoroughly acquainted with this part of the human anatomy. Complications are infrequent and of minor degree if ordinary care is taken. We present a consecutive series of 175 cases of perirenal air injection without serious mishap. In all instances added valuable information was obtained. We believe that the urologist need not hesitate to employ this procedure in the indicated case, although we advise against its indiscriminate use. No elaborate or expensive equipment is required.





# TOTAL DISRUPTION OF SURGICAL WOUNDS OF THE ABDOMINAL WALL\*

WITH REFERENCE TO PLASMA PROTEINEMIA AND PLASMA ASCORBIC ACID

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**D**ISRUPTION of abdominal wounds continues to be a distressing complication of abdominal surgery. Investigation during the last five years has emphasized the importance of protein metabolism and the rôle of vitamin c in wound healing. The deleterious influence of foreign bodies in the form of reactive suture material has been established both clinically and experimentally.

two surgeons had two eviscerations each, three had one evisceration each. The length of time following operation varied from four to fifteen days with an average of 9.1 days. Five of the seven incisions were above the umbilicus; two were left and three right rectus incisions. One right rectus incision had been made through a ten months' old scar with hernia. One right rectus incision had been made through a scar

	Case I	Case II	Case III	Case IV	Case V	Case VI	Case VII
Surgeon	A	B	A	C	B	D	E
Age	67	77	61	59	71	58	47
Carcinoma	yes	no	no	yes	yes	no	no
Incision	lt. rectus	rt. rectus	rt. rectus	lt. rectus	low mid.	rt. rectus	low mid.
Postoperative	13 days	9 days	13 days	6 days	7 days	4 days	15 days
Drainage through wound	yes	no	no	yes	yes	yes	no
Potentially infected	yes	no	no	yes	yes	yes	no
Cough	yes	no	yes	no	yes	no	no
Distention	no	no	slight	no	yes	slight	no
Peritonitis	no	no	no	yes	no	no	no
General nutrition	poor	poor	fair	poor	fair	poor	good
Plasma protein	6 53 to 5 82	6 02	6 43	5 82 to 6 10	6 03 to 5 70	7 62, 4, 12, 5 67	6 5
Plasma ascorbic acid	0 to 0 26	0 to 0 91	0 to 0	0 to 0 32	0	0 to 0 61	0
Hemoglobin	12 to 10 2	13 to 11	14 9	12 to 7 0	9 1 to 11 0	15 2 to 10 0	11 7 to 10 8
Died	yes	no*	no	yes	yes	no	no
Cause of death	Broncho-pneumonia	Carcinoma		Hemorrhage Secondary	Myocardial Infarct		

\* Patient died three months after dismissal with a generalized carcinomatosis.

In a series of 375 abdominal sections at the University of Nebraska Hospital, there were seven cases of total disruption of wounds with an incidence of 1.8 per cent. These cases were studied with special reference to proteinemia, detectable ascorbic acid in the plasma, and observations regarding the fate of catgut sutures.

These seven eviscerations occurred in patients operated upon by five surgeons;

five weeks old; at this time unabsorbed catgut with marked local reaction in the form of small abscesses was present. The two remaining patients had low midline incisions. Four of the seven were potentially infected cases. There was no unanimity as to the type of closure, although catgut was used in all cases for the buried sutures. Cough was present postoperatively as a complicating factor three times. Marked

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abdominal distention was present once. Drainage was instituted through the incision four times. The age varied from forty-seven to seventy-seven years with an average age of 62.8 years. Three of the seven patients had carcinoma; one of the esophagus, one of the pancreas, and one of the rectosigmoid. Six of the seven wounds were closed after disruption with through-and-through sutures. Resuture in layers was done in one case. All were sutured under local anesthesia in bed.

Three patients died while in the hospital—a mortality of 42 per cent—and one died three months after leaving the hospital from a generalized carcinomatosis secondary to an inoperable carcinoma of the head of the pancreas. The latter's wound (Case II) showed no evidence of hernia at death. Of the three patients who died while in the hospital, an autopsy was obtained on two. The cause of death in one (Case V) was a recent coronary occlusion with acute cardiac failure. The wound at the time of death was healed and there was no evidence of peritonitis. The other (Case IV) died of a secondary hemorrhage from a gastric ulcer at the site of repair of a gastrojejunocolic fistula. A marked bronchopneumonia was also present. No peritonitis was noted. The third death (Case I) resulted from malnutrition and probably a terminal bronchopneumonia. There was no evidence of peritonitis up to the time of death and no herniation was noted.

The general condition and nutritional status was good in one patient, fair in two, and poor in four. It is interesting to note that the general condition of the patients paralleled very closely the level of their plasma proteins. In six cases the plasma protein determinations were below the lower limit of normal, (6.5 mg. per cent); only one patient at the time of evisceration had a level of 6.5 mg. per cent (Case VII).

In none of the cases was there detectable ascorbic acid in the plasma at the time of total disruption. In five cases the administration of 150 mg. of ascorbic acid a day was inadequate to produce a detectable

quantity in the plasma within one week. One patient received 150 mg. a day for six weeks before its presence in the plasma was noted. Another patient had no detectable plasma ascorbic acid after four weeks' administration.

#### COMMENT

In general this report is in agreement with similar ones which have appeared in the literature. The incidence varies from 0.18 per cent to 3 per cent. In several instances the authors make no attempt to obtain any definite percentage. Grace<sup>9</sup> found forty-six in fifteen years, and came to the conclusion that it occurred most frequently with the split rectus incision. White<sup>16</sup> had seven disruptions in 406 cases with a mortality of 53 per cent. Meleney<sup>14</sup> presented fifty-five cases with an incidence of about 1 per cent. He recommended adequate closure of the posterior sheath of the rectus and suggests the more frequent use of the transverse incision. Bowen<sup>4</sup> agrees with this, but lays added stress on better preoperative management. Colp<sup>6</sup> reported an incidence of 0.9 per cent in almost 3,000 cases with a mortality of 28 per cent, and stresses the belief that the primary disease is the most important fact underlying the etiology of wound disruption. Glenn<sup>8</sup> lists 6,417 operative cases with an incidence of 0.66 per cent.

Following Thompson's<sup>15</sup> experimental observations in 1938 that wound healing is greatly retarded in the presence of hypoproteinemia, there has been an increased interest in this phase of the problem. He showed that wound healing is retarded whether silk or catgut was used, but that in experimental animals disruption was more common with catgut than with silk. No apparent attempt of union of the wounds was noted early, and fibroblastic proliferation was found only occasionally in the seven day sections of the wounds. In the fourteen day sections they were found but in greatly reduced numbers. He also noted that a decline in tensile strength of catgut is accelerated by hypoproteinemia. Lund<sup>13</sup>

states that 15 per cent reduction in the plasma protein, may lead to moderate delay in wound healing. When detectable plasma protein is reduced 25 per cent the loss is severe enough to cause serious delay or complete failure in healing. Elman<sup>7</sup> finds that hypoproteinemia reflects depletion in other tissues, but that the diagnostic value may be masked by complicating factors such as dehydration and hyperglobulinemia. He divides hypoproteinemia into acute and chronic phases. The acute phase may be due to hemorrhage, burns, intestinal obstruction, etc. The chronic type is nutritional in etiology, and he believes that the proportion of body protein depletion to plasma depletion is thirty to one. The consistently low plasma proteins obtained in six of the seven cases presented suggests that hypoproteinemia was one of the etiologic factors contributing to disruption.

In the last decade interest in vitamins has been increasing in every field in medicine and surgery. For wound healing an adequate balance of vitamins has been shown to be necessary. Bartlett<sup>1</sup> has shown in experimental animals that wide variations in guinea pig tissue may be caused by high or low intake of ascorbic acid, that the level attained preoperatively is of less value than that maintained during the postoperative period. He has also shown that the tensile strength is greater in wounds showing a high ascorbic acid level. In man, Bartlett<sup>2</sup> observed that a sufficient depletion of vitamin c produces a decreased ascorbic acid content and a decreased tensile strength in healing wounds in skin and fascia. He believes that the plasma level must be below 0.20 mg. per cent before these changes appear. In spite of the low plasma ascorbic acid level at the time of operation, normal wound healing may be produced by adequate vitamin c therapy during the postoperative period. Lund<sup>13</sup> believes that vitamin c deficiency causes a failure of deposition of collagen, that ascorbic acid must have been absent from the blood for several months to so

affect wounds, and that low grade infections increase the demand.

In none of the seven cases presented was any plasma ascorbic acid present at the time of total disruption. However, it is uncommon to find a surgical patient on our wards with detectable plasma ascorbic acid on admission. This finding questions the importance of a single negative ascorbic acid plasma determination. These patients received 150 mg. of ascorbic acid daily by mouth or parenterally. The patient in Case II, received this dosage for six weeks before ascorbic acid could be detected in the plasma. The patient in Case III received the same daily dosage for four weeks and at the time of dismissal still showed no detectable plasma ascorbic acid. Three other patients required at least one week's administration before it was detectable in the plasma. This would imply that the dosage of 150 mg. per day was grossly inadequate, and that the length of time required for ascorbic acid to become detectable in the plasma may be a measure of the depletion of this vitamin in the tissues. Lund<sup>13</sup> recommends 1 Gm. per day for six days as an initial dose and then a maintenance dose of 100 mg. per day. Buford<sup>7</sup> has found that 600 mg. per day is often necessary to obtain detectable plasma ascorbic acid.

It has been established that reactive suture material plays an inhibitory rôle in wound healing. Bellas<sup>3</sup> states, "I have become convinced that the emphasis in discussing sutures should be directed to whether a given suture is reacting or non-reacting." Wire has been shown to give the least reaction, with cotton, silk, plastigut, nylon and catgut in the order of increasing reactivity.<sup>11</sup> The degree of tissue reaction has been shown to vary with the size of the catgut.<sup>5</sup>

In the cases presented all of the buried fascial stitches were chromic catgut. They varied from No. 0 to No. 2 chromic. In one case (Case VI) the incision made through a five weeks' old wound revealed small abscesses around the knots of No. 0

chromic fascial stitches. In Cases I, II and VII there was no catgut found in the incision at the time of disruption thirteen, nine and fifteen days after the original operation. The absence and apparent early dissolution of suture material may have contributed to disruption.

Undoubtedly, other factors played a large part in the failure of adequate wound healing. In this series of cases, the factors of age, carcinoma, type of incision, drainage through the wound, infection, cough, distention and general nutrition unquestionably were contributory. All patients were over forty-seven years of age and four were over sixty. Three of the patients had carcinoma and were generally malnourished. Five of the incisions were split rectus in type, while two were lower abdominal midline incisions.

In this series of 375 abdominal operations, there were too few transverse incisions used to permit evaluation of this type of incision in the upper abdomen. From the standpoint of stress and strain upon the line of suture and of lesser damage of nerve supply and ease of suture of the posterior rectus sheath, the transverse incision has theoretical advantages.

The disrupting forces of coughing and of excessive distention were probably contributing factors in two cases (III and V).

The patient in Case III developed a post-operative atelectasis with incessant coughing, and the patient in Case V was markedly distended for a period following operation.

#### SUMMARY

1. An analysis of seven total disruptions of abdominal incisions is presented.
2. The presence of hypoproteinemia and of deficiency of plasma ascorbic acid in these cases and the possible influence of these factors is discussed.

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# EMPYEMA OF THE LUNG

## A REVIEW OF THE LITERATURE AND AN ANALYSIS OF ONE HUNDRED SIXTY-NINE CASES

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THE outbreak of World War II confronts us with the grave possibility of another devastating epidemic of pneumonia, complicated by a certain percentage of thoracic empyema cases. However, our tragic lesson of World War I gave us the pathophysiological principles laid down by the Empyema Commission and we can approach the subject with a much brighter outlook.

The treatment of thoracic empyema was known to Hippocrates who provided drainage by the thrust of a knife or cautery. Yet, two thousand years later, there was so little confidence in the surgical management of empyema that when Dupuytren, the ablest French surgeon of his time, was stricken with the disease (in 1835), he refused operation with the remark that he would "rather die by the hand of God than with the help of a physician."

Roe, in 1844, advocated aspiration as a therapeutic measure. Fifteen years later Goodfellow and DeMorgan introduced intercostal drainage. Walter in 1860, Roser in 1865, and Weissenbom in 1876 treated empyema by rib resection drainage. Bulau, in 1891, reported successful use of intercostal siphon drainage, which produced a certain degree of negative tension within the empyema cavity and prevented pneumothorax. Perthes first suggested continuous aspiration. Hutton in 1898, Baylor in 1899, and Williams in 1900 described an airtight dressing fitted with a valvular mechanism permitting escape of pus and air during forced expiration and coughing. Von Eberts described another method permitting negative tension drainage.

These methods of rib resection with

open pneumothorax continued until the pandemic of influenzal streptococcal pneumonia in 1918, when the mortality rate rose to 40 per cent. The Empyema Commission was appointed and laid down the principles for treatment which have continued to the present date, which are: (1) avoidance of open drainage during the stage of acute pneumonia, followed in nearly all cases by free drainage at a suitable time; (2) irrigation of the cavity, and (3) maintenance of the nutrition of the patient.

Graham and Bell demonstrated that the normal thorax must be regarded as one cavity instead of two. Any change of pressure in one pleural cavity is accompanied by practically an equal change in the other, so that equilibrium of pressure exists at all times throughout the whole thorax. The thorax is a movable structure which by varying the contained space also varies the pressure within. The older conception that a small opening into the chest would have the same consequence as a larger one is therefore not true. In any individual with a normal thorax a definite quantitative relationship exists between the size of the opening in the pneumothorax and the danger of death. The reasons for this are: (1) it is possible to maintain life as long as the lungs can inspire the "tidal air,"—normally from 300 cc. to 500 cc.; (2) a considerable encroachment on the volume of both lungs can be made before interfering with the tidal air; and (3) in the compensatory reaction, by increase in amplitude of the respiratory movements, the thorax is enlarged so that actually more air may

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enter through the pneumothorax opening without encroaching on the tidal air to the same extent as though the thorax were not

Pneumococcic empyema presents an entirely different picture. By the time the pleural effusion is recognized, the pneu-

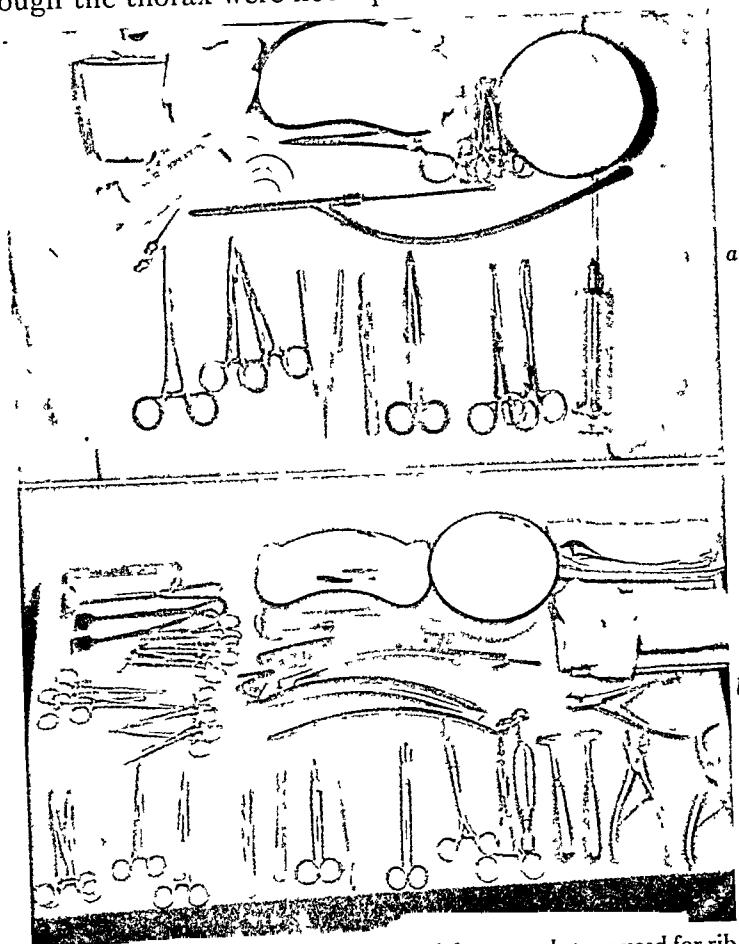


FIG 1. a, Tray used for intercostal closed drainage, b, tray used for rib resection.

enlarged. These conclusions do not hold good if adhesions are present or the mediastinum has become rigid by induration. By the time the pneumonia has subsided and open drainage is established, the "vital capacity" has increased so that a small opening will not induce fatal asphyxia.

During the early stages of acute empyema, particularly the type due to hemolytic streptococci, patients are cyanotic and suffering from air hunger to a marked degree. Their "vital capacity" is practically equal to the "tidal air." It is most important to avoid an open pneumothorax until these dangerous factors have disappeared.

monia has subsided and conditions are ready for operation. It is important to identify the type of organism before starting open drainage.

Another serious effect of open pneumothorax is loss of heat. Sauerbruch has shown that it may be enormous. Sakur also found marked diminution in amount of oxygen in the blood.

#### ETIOLOGY

Empyema *per se* is rarely, if ever, a primary disease. It is most frequently secondary to pneumonia, influenza, or measles. Neuhoef and Hirshfield found putrid empyema as a complication of pulmonary abscess. Other causes of putrid

infection are putrefaction after intrapleural hemorrhage, necrosis of the lung following infarction or trauma, and pleu-

enza or measles, and less often associated with pneumococcal infection or other inflammatory lesions of the lungs. How-



FIG. 2. Procedure for aspiration and closed intercostal drainage. *a*, Aspiration of chest; *b*, insertion of trocar with threading of catheter, *c*, catheter in place showing method of anchoring tube.

ral invasion from a putrid subphrenic abscess. Maier and Grace reported putrid empyema secondary to bronchiectasis, pulmonary abscess, and suppurative pneumonia. They were also able, with the aid of Coulter, to correlate foul dental sepsis with putrid empyema secondary to intrapulmonary disease. Kline and Berger reported twenty-six cases of empyema among fifty-five cases of spirochetosis. DeBakey expected a rise of empyema secondary to penetrating chest wounds from this total war. Empyema may also be caused by primary tumors which have obstructed a bronchus.

Weinstein has reported subdiaphragmatic (perirenal) extension into the pleural space. Lane and Francis found the bacillus typhosus in the purulent fluid forty years after the initial attack of fever.

Operative procedures such as diagnostic aspirations or aspiration biopsies may carry infecting organisms into the chest cavity or produce empyema by penetrating the lung or esophagus.

Keefer, Rantz, and Rammelkamp stated that hemolytic streptococcal pneumonia occurs most often following epidemic influ-

ever, they associated hemolytic streptococcal pneumonia with chronic processes in the lung—asthma, bronchiectasis, and chronic cystic disease.

Approximately 75 per cent of all empyema is due to the pneumococcus, 15 per cent to streptococcus, and the remaining 10 per cent to staphylococcus, influenzal, and other rarer types of organisms. Lanman and Heyl indicted the pneumococcus in 80 per cent of the cases, *Staphylococcus aureus* and *Streptococcus hemolyticus* in another 10 per cent. In bacteriological examination of the pus the pneumococcus was found in 63.9 per cent, the streptococcus in 9.4 per cent, and the staphylococcus in 6.5 per cent. Combinations of the three were less frequent.

From the results of the past few years with the use of type specific serum and sulfonamide therapy, it is reasonable to expect a reduction in the frequency of empyema due to pneumonia. Schwartz, Flippin, and Turnbull found that of a group with pneumococcal pneumonia 10 per cent treated with type specific serum, and 23 per cent of those given sulfapyridine subsequently developed empyema. The

streptococcus showed the highest mortality of the groups—33 per cent. Other organisms were found in 0.6 per cent.

The most unusual case is reported by Zwirn, Joyeux, and Aboucaya, of empyema following an appendectomy. On open

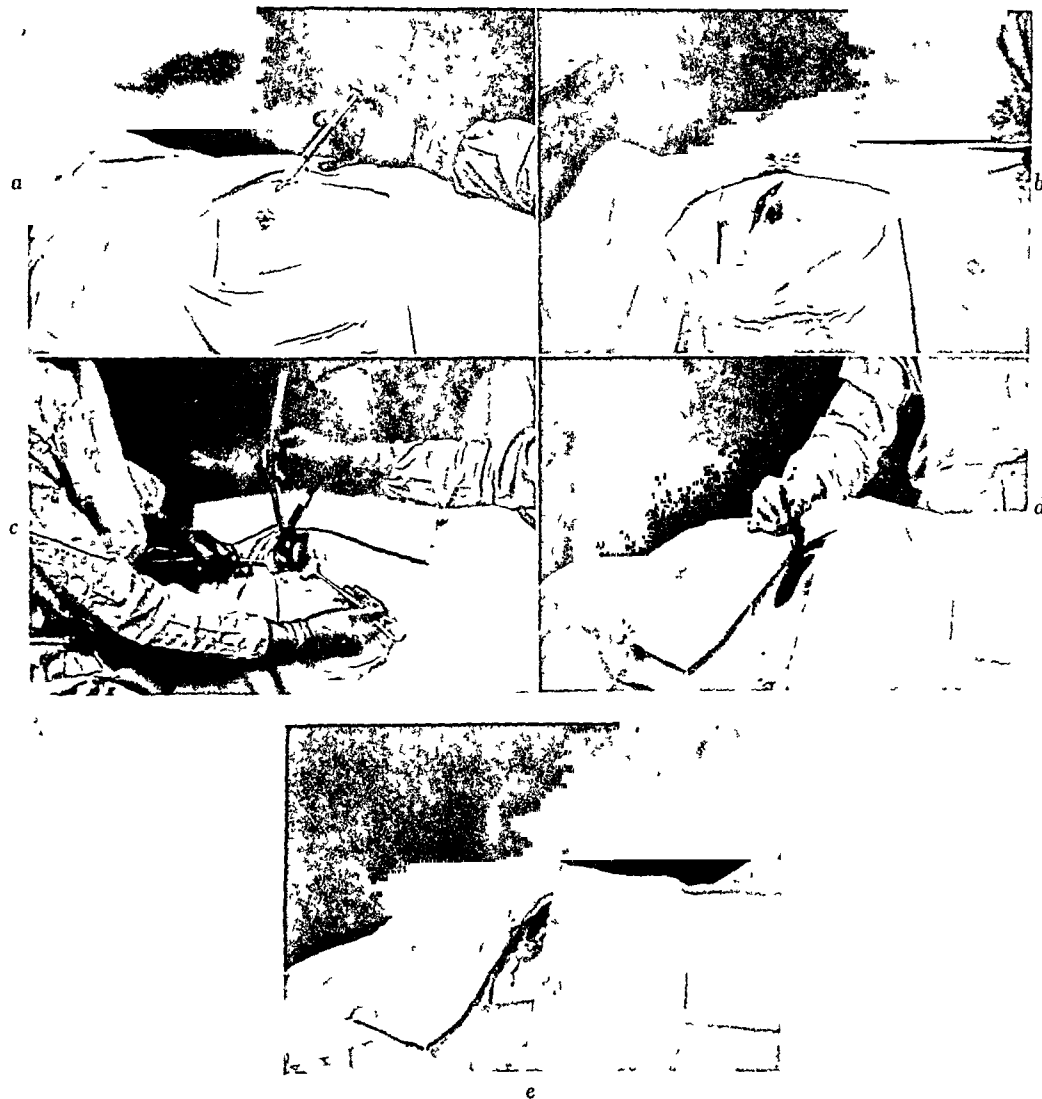


FIG. 3. Procedure for rib resection. a, Infiltration with novocaine of skin; b, skin incision; c, resection of rib; d, placing of drainage tube; e, completed operation.

Empyema follows pneumonia in only about one-tenth of the total number of patients. Hurwitz and Stephens found it in 9 per cent of pneumonia cases in children under twelve years of age. Penberthy and Benson had an incidence of 7 per cent.

Some of the rarer organisms producing empyema are the *Brucella abortus*, reported by MacDonald. Bisgard reported two cases of actinomycotic empyema. Others have reported the colon bacillus.

thoracotomy a male *Ascaris lumbricoides* was identified.

#### DIAGNOSIS

Diagnosis of empyema depends upon septic temperature, flatness on percussion, roentgenographic findings, and aspiration of pus from the chest. If only a small amount of pus can be aspirated from the chest cavity, it is possible that the needle has penetrated lung tissue and aspirated



a small pulmonary abscess. Diagnosis may be difficult, as revealed by the large number of patients who present themselves

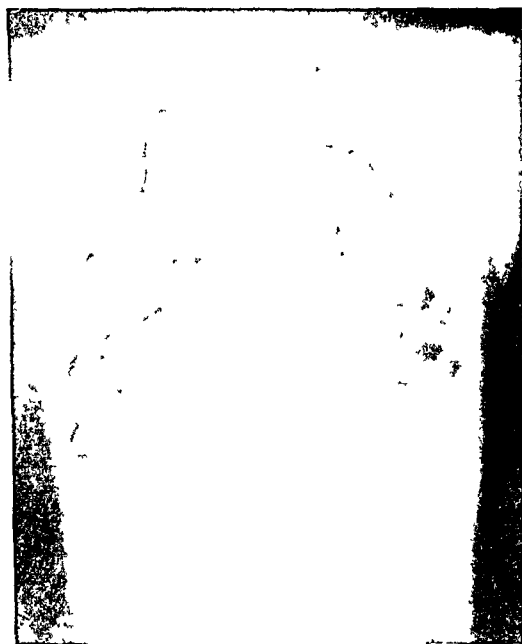


FIG. 4 Encapsulated empyema.

with chronic empyema of months' and even years' duration. It is now well known that pneumococcic empyema usually occurs some time after the pneumonia has subsided (metapneumonic), whereas the streptococcic type is usually concurrent with the pneumonia (synpneumonic). Unresolved pneumonia usually means empyema.

It is important that diagnosis be made early. Treatment consisting of thorough and rapid evacuation of pus should be instituted, to spare the patient prolonged infection and complications. It has been said that "Patients do not die from empyema *per se*, but from the complications that arise as a result of the pleural effusion." Fitzgerald has emphasized that delay is dangerous to the fundamental value of the lung.

Frequent and early roentgenograms will produce many more early diagnoses. Evans has observed that there is a certain amount of fluid in the pleural cavity in very early pneumonia, but that most of this is very readily absorbed and does not go into a

pleural abscess. This is particularly true in children. Roentgenograms should be made in the oblique as well as the frontal and lateral planes, as many interlobular, encysted, and pulmonary abscesses may be demonstrated.

Thomas stated that roentgenograms should always be made before operative treatment. Aspiration should be done only after the diagnosis has been made, and then only as a prelude to operation. Of all the diagnostic procedures, aspiration remains the definite means of diagnosis after accurate localization of the pus by the roentgenograms. The actual demonstration of pus is important in determining the presence of empyema, its site, the nature of the infecting organism, and the physical characteristics of the pus. The aspiration of tuberculous pus may lead to disastrous results if treated by open or closed thoracotomy. Aspiration is also important in determining the proper drainage site. Harrington believes that the aspirating needle should be left in place and an immediate operation performed; but most workers believe this is unnecessary except in putrid empyema, which demands immediate operation to prevent anaerobic infections of the chest wall.

Olesen and Hansen have used a supravital staining method differentiating between living leukocytes and dead ones.

White and Collins suggest that the proper time for drainage is when there is no more than 10 per cent supernatant fluid after a partially filled test tube of pus has stood for twelve hours.

Pearse has determined the specific gravity of pus in thirty-six cases of empyema caused by pneumococcus, streptococcus, and staphylococcus. There was progressive increase in specific gravity which reached a constant level in about twenty-one days, at which point it is safe to do an open drainage. Manometric readings of the intrapleural pressure are helpful in determining the time for drainage. A fixed pressure indicates that there is a localized collection of pus and that the mediastinal

structure is sufficiently fixed to allow safe drainage.

Graham, Singer, and Ballon believe that

respiration. After localization two phenomena are observed: (1) no movement, seen in bilateral and sometimes unilateral

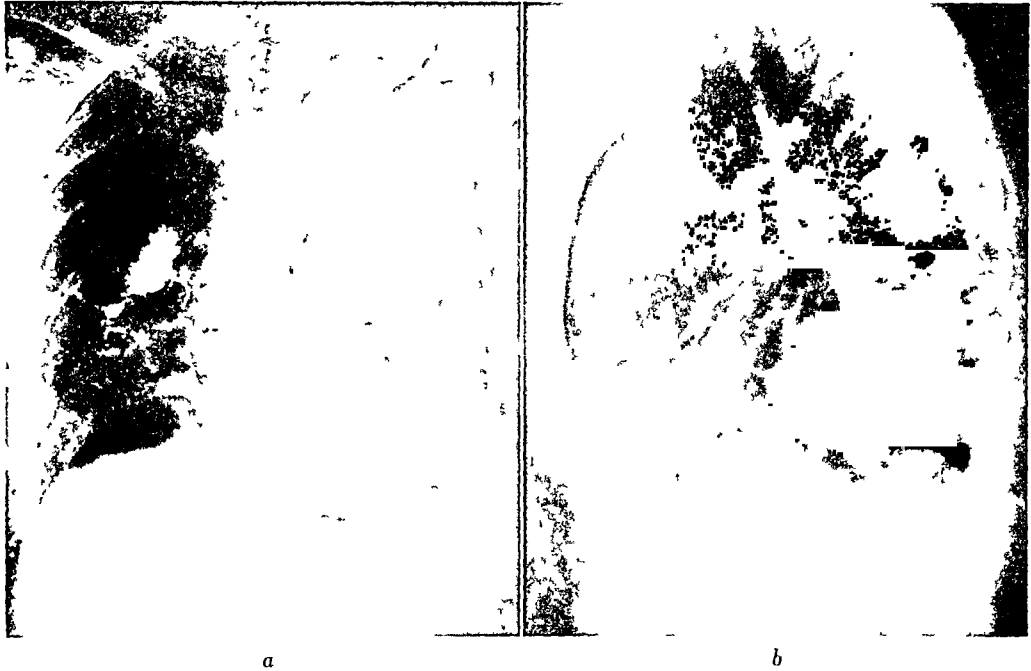


FIG 5. Residual cavity injected with diodrast *a*, Anteroposterior view, *b*, lateral view.

in acute empyema repeated aspiration should be done until the exudate has become "frank creamy pus."

Another method which requires the observation of a skilled, highly trained roentgenologist who has observed many of these cases, is described by Berman, and is based on the fact that in a normal child the mediastinal shadow is narrowed during inspiration and widened during expiration. This condition prevails until localization takes place, after which there is very little movement of the mediastinum or diaphragm on the affected side. In twenty-seven cases he found fixation between the seventh and tenth day. He has developed some greatly simplified methods of fluoroscopic examination of the child with empyema. A thoracentesis is done to determine the type of organism, partially to empty the cavity of pus and also to inject air. First the child is observed in the upright position. The fluid level is easily seen and before localization moves with

empyema; (2) paradoxical movement, seen in unilateral empyema due to exaggerated movement of the opposite leaf of the diaphragm. In order to observe the movements of the diaphragm the patient is tilted in the head down (Trendelenburg) position, when the diaphragm can be easily seen if sufficient air is present in the empyema cavity. Twenty to 30 cc. of pus are aspirated and an equal amount of air injected. Fixation of the diaphragm implies localization.

To observe the mediastinum, the patient is turned to the affected side in anteroposterior (lateral decubitus) plane. The pus gravitates away from the mediastinum, permitting observation of its movements. If this is fixed, the cavity is completely localized and open drainage may be safely done. When the sulfonamides are employed the use of the fluoroscope is necessary to determine the proper time for this procedure, because other criteria, such as character of the pus, leukocyte count, and

temperature range are not then reliable guides.

In location, empyema is usually found



FIG. 6. Massive pleural effusion with fluid level.

in one of the lower lobes but it may be multiloculated. Recognition of multiple loculation depends upon careful study of postero-anterior, lateral, and oblique roentgenograms. The foci should be drained as they are recognized, either through original or supplementary incisions.

#### TREATMENT

In any treatment of pleural empyema, the objectives to be attained are: the nutrition of the patient; drainage as complete and as early as possible; and expansion of the lung. To be excluded are: operative shock, mediastinal flutter, and chronicity.

Ehler and Graham have stated that the first aim should be to save lives. Secondary to this are: (1) complete evacuation of pus; (2) rapid elimination of toxicity and systemic effects; (3) sterilization and subsequent complete closure of the cavity with obliteration of all foci of infection; (4) complete healing of the external wound; (5) restoration of the patient to his normal

social and economic position; (7) avoidance of chronic empyema and recurrences; and (8) accomplishment of these results in as short a time as possible.

After a pleural abscess has once formed, adequate surgical drainage is demanded in almost all cases. Open drainage during the developmental stage is fraught with so much danger that it should not be undertaken.

The closed method of drainage relies on the introduction of a catheter without admitting air into the pleural cavity. The open method, by rib resection or removal of muscle bundles, allows free introduction of air.

Tixier and Eck have had success with sulfanilamide derivatives for patients with streptococcic empyema who are too ill for surgery; but Lester, after prolonged treatment with sulfanilamides and prontosil in adequate doses, plus repeated aspirations, found surgical drainage necessary to effect cures.

Bowen reported two cases in which the patients had spontaneous cures from drainage through bronchopleural fistulas.

Each of the three recognized forms of treatment, aspiration, intercostal closed drainage, and open thoracotomy, with or without rib resection, has its own field of usefulness and its contraindications, and stubbornly to adhere to any one of them for all cases is to invite disaster.

#### ASPIRATION

Aspiration should be used in all cases at the beginning of treatment; and should be repeated preliminary to operation, to relieve mechanical embarrassment due to accumulation of fluid in the pleural cavity, and alleviate toxic symptoms during the synpneumonic stage.

Injection of air following aspiration has been a very common procedure; however, Carlson has experimentally shown that empyema heals by progressive formation of adhesions between the parietal and visceral pleura, confirming Heuer's earlier work. Fluid should be aspirated frequently

to prevent dyspnea. To make the aspirations more comfortable, Brock makes a small initial incision at the first aspiration

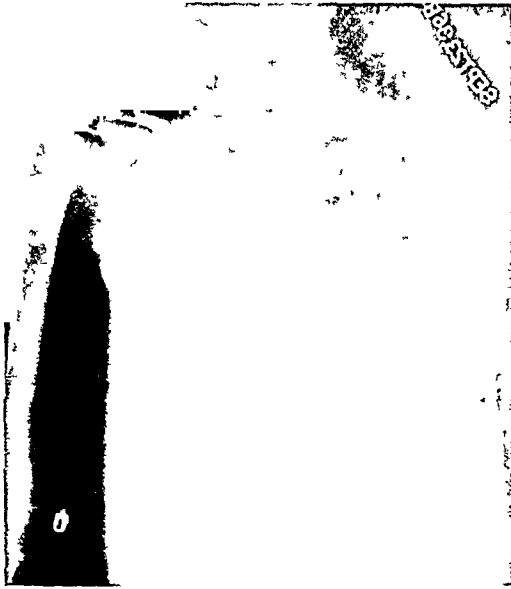


FIG. 7. Loculated empyema.

down to the parietal pleura, which is kept open by a small pack removed at each aspiration.

Multiple therapeutic aspirations should be done in encysted empyema, followed by injection of air, in order to outline the cavity in the roentgenogram. Aguirre is of the opinion that if this method fails after four or five trials, thoracotomy should be done.

Arneson reported twelve cases of post-pneumonic empyema treated by multiple aspirations and irrigations with a weak aqueous solution of iodine or rivanol. Sworn and Cooper treated three patients by aspiration of pus and injection of 5 to 20 cc. of a 5 per cent solution of sodium desoxycholate. Merthiolate, optochin, iodized oil, sodium chloride, sodium taurocholate, have been used for irrigation purposes.

While the diagnosis of thoracic empyema should never be made without introduction of a needle and removal of pus, the treatment of empyema by multiple aspirations should not be continued after four or five aspirations unless the patient shows a marked response to the treatment.

#### INTERCOSTAL CLOSED DRAINAGE

Intercostal closed drainage is particularly advised where reabsorption of fluid after aspiration is so rapid that even daily aspirations fail to give adequate relief.

Closed operations are those in which a catheter is inserted into an empyema cavity through an intercostal space without exposure of the parietal pleura. After local infiltration with 1 per cent novocaine a No. 18 F catheter is introduced with a trocar and cannula. The wound must be small enough for the drainage tube to fit snugly, taking precautions against allowing air to enter and inserting the tube too far. If intercostal drainage is made at the most dependent interspace, the diaphragm rises as the fluid drains off and may interfere with adequate drainage. The seventh interspace is usually chosen for intercostal drainage. In patients who later require rib resection the diaphragm may be higher than at the time of intercostal drainage. The rib above the site of intercostal drainage gives better drainage and will obviate the chance of inadvertently going through the diaphragm. The posterior axillary line is chosen in most cases. After removal of the fluid, which should not be done too rapidly, a closed system of drainage may be instituted by the use of flapper valve (Bohrer, Lillenthal) or a water seal, or siphon drainage may be used with or without continuous suction.

It is believed that no form of closed drainage stays absolutely airtight for more than a week or two. Bettman reported twelve cases whose roentgenograms on the tenth postoperative day showed a small amount of purulent discharge about the wound and no pneumothorax present. The wound itself acted as a valve.

Airtight drainage for more than two or three weeks is rarely necessary. It should not be continued longer than this unless there is improvement shown by the clinical conditions with a decrease in the size of the cavity and re-expansion of the involved lung. If a week or two of intercostal closed drainage does not prove adequate, espe-

cially in the pneumococcal type, the patient's condition should be improved sufficiently to warrant open surgical drainage. The rare patient whose general condition has not improved sufficiently to warrant open drainage after two or three weeks of closed drainage usually presents another complicating factor, frequently bronchopleural fistula.

#### OPEN DRAINAGE

In properly selected cases, open drainage is one of the most efficient methods of treating empyema, since it allows exploration of the pleural cavity for identification of bronchial fistulas and possibly accessory empyema pockets, and permits complete removal of all fibrin masses and proper placement of the tube.

Lanman and Heyl have adopted the rule of "not doing a rib resection in a child two years of age or younger, who has not had a preliminary intercostal closed drainage."

White and Collins have reported 317 cases in which there was a mortality of 26.2 per cent with treatment by aspiration alone, 11.4 per cent with closed drainage, 23.6 of the survivors needing secondary rib resection; and 6.5 per cent with rib resection.

Keefer, Rantz, and Rammelkamp state that even when sulfanilamide is used open drainage of the pleural cavity will be required in most cases. They have observed recurrences of infection as long as three to five weeks after temporary sterilization of the empyema cavity.

Burpee had a mortality of 14.3 per cent with intercostal drainage, and 16.2 per cent with rib resection, while Mason had 20 per cent mortality with intercostal drainage, and 6.94 per cent with rib resection.

Lanman and Dimmler state that the average duration of postoperative drainage after primary rib resection was twenty-four days, after intercostal drainage forty days, and after intercostal drainage followed by rib resection fifty-seven days. A greater percentage of their patients with pneumococcal empyema who had chemotherapy

needed radical open drainage sooner in the course of the disease than those who did not have chemotherapy. The exudate on the pleura is thicker and more tenacious and very difficult to clean up by closed methods.

Hockberg and Kramer have reported closed intercostal drainage used in sixty-four patients with eleven deaths; open drainage with rib resection in 134, with only seven deaths (5.6 per cent).

One of the newer types of open operation, suggested by Connors, makes an incision along the rib line over the central portion of the empyema cavity. Two or three inches of two ribs, as a rule, are removed subperiosteally, intercostal muscles, vessels, and nerves being removed *en masse*. The empyema cavity is gradually opened, leaving a window into the pleural cavity about two inches in diameter. The cavity is cleared of pus and fibrin and if there are several lobules they are made into one. Packing is then inserted into the entire cavity with fairly firm pressure. It is now the practice to remove the packing on the second or third postoperative day and, with rare exceptions, not to repack. Iodoformized gauze has been replaced by plain gauze, since it was occasionally toxic. Great care must be exercised to maintain an orifice in the chest wall until the lung has expanded. The mortality with this method was 6.6 per cent in seventy-four cases. Of the five patients who died, two had several contralateral pulmonary infections, one had an overwhelming toxemia following miscarriage and pneumonia, and the others died of complications. It has been the author's practice to use this method in putrid empyema.

Ehler summarizes his plan of treatment as follows:

1. A proper method of aspiration to reduce toxic absorption and intrapleural pressure and allow time for fixation of the mediastinum.

2. When the pus has become walled off, a segment of rib at the most dependent point of the cavity should be removed

and a large rubber tube inserted in the cavity.

3. This tube, which should be sufficiently large to allow complete drainage of all pus and fibrin masses, should fit snugly in the pleural opening in order to be airtight.

4. The distal end of the tube should be connected to a suction apparatus to produce varying degrees of negative pressure as desired.

5. The tube is not to be removed permanently from the chest until the intrapleural cavity is completely closed.

This method of treatment has been found entirely satisfactory in all types of non-tuberculous empyema, and in infants as well as in children and adults. Very rarely, and then only because of the very precarious condition of the patient, drainage by means of intercostal catheter may be resorted to, but only as a preliminary to an almost inevitable rib resection.

#### ANESTHESIA

Thoracic empyema patients, having a reduced vital capacity, are in a state of air hunger a greater part of the time, hence the anesthetic that gives the least pulmonary embarrassment should be selected. It must (1) avoid reducing vital capacity below the level to which the patient has become accustomed during his illness; (2) allow lateral position of the patient on the operating table, on his sound side; (3) prevent loss of blood, as the thoracic wall is a very vascular bed; and (4) deal with the copious amount of sputum.

Diagnostic and therapeutic aspirations can all be performed by local infiltration of novocaine or one of its derivatives. Rib resections can be done under local anesthesia, but some patients object to the cutting of the rib and a general anesthetic must be given.

Maingot has found pure nitrous oxide oxygen anesthesia with a premedication of morphine and scopolamine very satisfactory. To overcome the collection of too

much sputum, the patient is placed in a slight head down position.

The mucus-producing quality of ether is a contraindication for its use.

Ethylene is a good general anesthetic and seems to meet all these requirements. It has an added advantage of allowing a higher intake of oxygen. Cyclopropane maintains the highest percentage of oxygen in the circulating blood, which is so important in patients with reduced vital capacity. Unfortunately, in a certain percentage of patients who have cardiac lesions, it is contraindicated and may prove fatal by producing ventricular fibrillation.

Positive pressure anesthesia should be used when the pleural cavity is opened.

Endotracheal anesthesia and suction must be employed in the presence of copious amounts of sputum.

Behrend has successfully used intravenous sodium pentothal with inhalation of 100 per cent oxygen in empyema complicated by bronchial fistula.

#### POSTOPERATIVE TREATMENT

The postoperative treatment of thoracic empyema, particularly in children, is of paramount importance, for on it depends the rapid and complete recovery of the patient. Adherence to the minute details is mandatory, to prevent too early closure of the cavity and a resultant chronic infection.

Immediate attention to the drainage apparatus will require minute nursing skill. Postoperatively, open drainage may be maintained in such a manner that to-and-fro exchange of air between the pleural cavity and the exterior is permitted by use of gauze dressing over the drainage opening, requiring only the minimum care of changing dressings. However, most cases have some form of drainage tube which must be irrigated and cleaned daily.

To determine when the cavity is completely obliterated, Berman says, is very simple. It will be found that no more fluid can be injected into the chest without its either pushing the catheter out of the chest

cavity or immediately spurting out around the sides of the catheter. Then and then only is it safe to remove the catheter. After the large Pezzar catheter has been removed it is replaced by a smaller caliber black rubber tube, which is allowed to remain open and is anchored to the chest wall by adhesive tape. This tube is irrigated once or twice a day, and is removed after a week, provided it has not been forced out by granulation.

Since too early removal of the tube is a frequent cause of recurrent empyema, Cabitt and Hurwitz think it should be removed only after injection of lipiodol demonstrates a completely healed pleural space. Only by the use of roentgenograms after the instillation of iodized oil, can accurate determination of the size of the cavity and the progress of healing be made. Care must be taken to have the drainage opening uppermost and to insert the instillation catheter to the most distant point of the cavity.

Roentgenograms, to be of use in postoperative empyema, should be taken by the Potter-Bucky technic so as to provide sufficient penetration of the thick pleura to outline the empyema cavity accurately.

Physical examination of the chest is of little value. Frequent estimation of the capacity of the cavity along with frequent roentgenograms are the only accurate methods of determining progress of the disease.

Following the evacuation of the pus and the receding in size of the empyema cavity, the re-expansion of the lung is followed closely. Blow bottles have long been used to aid and increase the speed of re-expansion of the lung and reduction in size of the cavity. Gumpel has described a system which is cheap, easy to make, light, and readily used by the patient.

The majority of workers agree that blow bottles develop the accessory respiratory muscles and improve re-expansion of the lung, but if Carlson's experiments be accepted, proving that the pleural cavity

heals by progressive formation of fibrous adhesions between the visceral and parietal pleuras, their value is questionable. The combination of a large drainage tube and continuous negative pressure drainage led to practically complete expansion of the lung and rapid healing in thirteen cases of acute empyema, but was unsuccessful in chronic empyema. Mitman and Bagg have used the Drinker respirator to promote expansion of the lung in cases in which there was no noticeable expansion after many weeks.

Lloyd has described a suction irrigation apparatus for postoperative drainage of thoracic empyema cases. The essential difference between this system and any of the many negative pressure methods which have been devised, is that a two-way catheter must be inserted into the chest cavity, which may be done according to Harloe's method. The pus is drawn slowly from the patient's chest by a siphon system until a partial vacuum is established within the pleural cavity. Irrigating fluid is then sucked in and completed circulation begins. In the majority of cases all pus can be removed in from fifteen to twenty minutes. The quantity rapidly decreases. In acute cases ten to fifteen days is sufficient to obtain an almost clear return flow. At this point the empyema is considered cured and the apparatus removed.

It is difficult even now to make any final remarks on the efficiency of the sulfonamide drugs in the treatment of pneumonia, since there are so many variable factors in its treatment. A few facts of significance have emerged, namely, sulfanilamide does not produce any dramatic change in the course of hemolytic streptococcal pneumonia, and it does not seem to reduce the incidence of empyema. Keefer et al. conclude that sulfanilamide will influence the outcome of hemolytic streptococcal pneumonia and empyema by reducing the fatality rate. Nowak reported that in patients who did not receive sulfanilamide the fatality rate was 48 per cent, while in those who received it, it was

29 per cent. Leahy reported seven cases of hemolytic streptococcal empyema in which the patients were treated with sulfanilamide, aspiration of the chest, and open thoracotomy, with only one death. Sulfanilamide with multiple aspirations of the pleural cavity or rib resection were employed with recovery, but sulfanilamide with closed drainage resulted in death. From these cases it would appear that in some young patients multiple aspirations and sulfanilamide may be sufficient. All these patients develop a secondary anemia which is accentuated by the sulfanilamide and they should receive whole blood transfusions.

Lastly, but most important of the post-operative care, is maintenance of the patient's nutrition. He should receive a well balanced, high caloric, high vitamin diet. The loss of plasma proteins from the large, raw necrotic area of the pleural abscess cavity may be compared to the loss of plasma proteins from a burn of like size and must receive transfusions of plasma, as well as whole blood transfusions.

#### COMPLICATIONS

Empyema complications result in most instances from long delayed treatment. If not drained surgically, the pus may burrow in many directions, causing perforation into a bronchus or empyema necessitans, or perforation into the trachea, esophagus, pericardium, blood vessels, or mediastinum. Occasionally, it may penetrate the diaphragm to the peritoneal cavity or extraperitoneally. Perforations of the esophagus may be due to foreign bodies, strong chemicals, carcinoma, peptic ulcer, rupture of a diverticulum, trauma, or may occur spontaneously during severe vomiting. Young reported a case of erosion of the esophagus by a hard rubber drainage tube. Blauvelt and Torbett and Bennett have treated cases of pleuroesophageal fistula by rib resection, tube feeding, gastrostomy, rectal feeding, and direct closure of the fistula.

Berman and Walters claim that broncho-

esophagopleural fistula is the result of at least two factors: first, some congenital anomaly of the esophagus and bronchus, and second, an erosion through an anomalous area. Press and Altman observed a case in which a parapharyngeal abscess burrowed laterally into the pleura in the axillary region, causing empyema, myositis, and death.

Transdiaphragmatic and retrodiaphragmatic extension of infections may occur. Hochberg stated that 85 per cent of cases of subphrenic abscess presented thoracic complications, and that 45 per cent of these were referable to the thorax. Beyer considers the diaphragm an efficient barrier against extension of infection from the thorax to the abdomen. Direct invasion through the diaphragm occurs at first via the lymphatics and later, with more severe infection, gross invasion of the musculature takes place with actual perforation. The normal lymphatic drainage in this region is directed upward, which is one of the factors in thoracic complications of subphrenic infection. A case was reported by Tees, in which a lumbar abscess could be traced upward from the quadratus lumborum muscles, behind the lumbocostal arches, to an infrapulmonary empyema.

Infections of the chest wall are not regarded as serious complications and are rather infrequent. They may be prevented by packing the wounds with vaseline gauze. In putrid empyema with anaerobes and micro-aerophilic streptococci, the wound edges should always be kept well apart and treated with zinc peroxide, as described by Johnson and Meleney. Brandburg has reported a case of progressive gangrene of the chest wall after tight skin closure which was cured by multiple wide skin incisions and numerous skin grafts.

Hill describes a patient who, after drainage of an empyema, noticed that his left hand, arm, and shoulder did not sweat but were hot and dry. This disturbance of the thoracic sympathetic trunk lasted only about a month.



Scoliosis is a complication of empyema which varies directly with the duration of the empyema and inversely with the age of the patient. It may be found in most younger children and rarely leaves a permanent deformity. Persistence of deformity is indicative of an undrained pocket of pus. Chandler found only one case of persistent scoliosis among 280 cases of empyema. If the hemithorax is very full of pus, the curvature is convex toward the affected side, but when the hemithorax is not very full and when the intercostal muscles are in spasm the curve is concave toward the empyema side. Bisgard states that thoracic spinal curvatures are pleurogenic or result from thoracoplasty. With early cure the muscles relax and the curvature corrects itself spontaneously. If the disease becomes chronic or produces much pleural scar tissue, a spinal deviation occurs with the convexity projecting into the healthy side, the reverse of that caused by thoracoplasty. In this type there is little or no rotation of the vertebral bodies, hence no posterior bulge of the thoracic wall. The mediastinum, fixed to the spine by scar tissue, usually deviates with the spine and, together with reduction in size of the hemithorax and the relative fixation of the lung, leads to reduction of the vital capacity proportional to the deformity. The younger the individual, or the more chronic the empyema, the more likely and more extensive is the curvature. Scoliosis following thoracoplasty is of a rotary type. The Schede type of thoracoplasty produces more imbalance than extrapleural thoracoplasty. Corrective measures should be instituted immediately following surgical drainage, consisting of overcorrection of the deformity by allowing the patient to lie on a rolled pillow high in the axilla on the diseased side, or a plaster mold for young children or a plaster body cast for ambulatory patients.

#### CHRONIC EMPYEMA

A proper understanding of the pathology and pathological physiology of acute empy-

ema, and its application to the treatment of the disease would render chronic non-tuberculous empyema a clinical rarity. Muller states that most important in the prevention of chronicity is adequate drainage, carried out at the proper time and continued until the cavity is obliterated. Delayed drainage until fibrin has covered the visceral pleura with a thick layer will prevent expansion of the lung and make for chronicity, also premature removal of the drainage tube before the cavity is obliterated will permit superficial healing of the drainage tract and maintain the residual pocket of empyema. The tube should remain in place until the entire cavity has been completely obliterated and only the superficial wound remains, and that should heal from the depths outward.

Next in importance to adequate drainage is proper placing of the drainage tube. Figarella believes that non-dependent drainage is an important cause of chronicity. The mid-scapular line is the favored site, the tube being placed at the lowest point with the patient in the erect position. The proper site will be determined after the roentgenograms have been taken and an aspiration biopsy done at the operating table.

After thorough digital examination to determine the size, extent, and height of the cavity, and careful removal of excess fibrin, the drainage tube is selected. It should not be too long, in order to prevent necrosis and to insure good dependent drainage. The fenestration should not be placed in the apex of the tube. Multiple fenestration may become clogged with thick fibrin. If it is too short the patency of the pleural opening will not be maintained. The inner opening of the tube should be just within the parietal pleura.

Martin lists the causes for expansion of the collapsed lung as: (1) the pull of the contracting granulations at the reflection of the parietal pleura on the visceral pleura as the two layers fuse; (2) positive pressure in the trachea and bronchi from

the sound side during forced expiration driving air into the collapsed lung; (3) negative pressure in the empyema cavity during inspiration when the diameter of the drainage opening is smaller than that of the main bronchus. This occurs only when the walls of the abscess cavity yield sufficiently; therefore, a chronic empyema results when the walls of the newly formed connective tissue replacing the pleura are too thick and inelastic to permit the lung to expand and initiate healing at the angle of reflection.

If there is evidence of a considerable cavity four or five weeks after drainage of the purulent exudate, and if the tissues are not well healed about the tube, it is well to do a secondary rib resection, removing the rib above or below the original drainage. The same holds true for any secondary abscess draining into the main empyema cavity. Hindrance of free outflow of the discharge in a secondary cavity results in more invasion of wall and more protective response from the surrounding tissue.

Chronic empyema implies attenuated infection, such as might readily occur with intermittent discharge slightly slower than accumulation or undrained discharge. The essential cause is granulation tissue replacing the pleura under repeated infection.

Pulmonary fibrosis may develop slowly in an unexpanded atelectic lobe, due to prolonged bronchial obstruction, which Butler states may be produced by excess pleural exudate upon a lobe or lobes still filled with pneumococcic secretions.

Bronchopleural fistula, the commonest cause of chronic empyema, is one of the easiest to cure. Adequate drainage is usually all that is necessary, though very large bronchopleural fistulas may require extensive plastic procedures.

Another cause, fortunately not common, is presence of foreign bodies in the pleural cavity. The surgeon should give careful attention to details, such as insecure gauze dressings and drainage tubes falling unnoticed into the pleural cavity; proper rib

resection so that all bone chips are removed, and prevention of osteomyelitis by Overholt's method, turning a periosteal flap over the end of the rib, or cutting squarely.

In treatment of chronic empyema, the more conservative step should be given a fair trial before attempting more mutilating ones. Lloyd has reported seventeen cases in which the patients were cured by continuous suction of from 12 to 16 inches of water. Others have used higher negative pressures and obtained satisfactory results, but the pressures must be lowered slowly to prevent bleeding from capillaries and larger blood vessels. If these methods fail, more radical operations must be done, the type depending upon the individual.

Carter lists the three classes of chronic empyema requiring surgery as: (1) secondary tuberculous empyema, (2) pyogenic empyema of several years' duration, and (3) chronic empyema with bronchial fistula.

In 1890, Schede published thirteen cases in which after rib resection of one or two ribs the cavity persisted. To collapse the thick walled cavity, he resected the whole length of the rib, in several cases removing all the ribs from second to ninth, then cutting away the thoracic wall. In every case resections were carried out in two or three stages.

Delorme reported a recovery by removal of pulmonary pleura, allowing the inner wall of the rigid cavity to become yielding and the expanding lung to fill the cavity. He thus avoided the deformity resulting from Schede's resection of the chest wall.

Ranschoff uses multiple gridiron incisions through the visceral pleura to aid expansion of the lung. Extrapleural thoracoplasty is a method of indirect attack on chronic empyema cavities. If a residual cavity persists even after thoracoplasty, it must be eliminated by some form of unroofing operation. The Schede type is of value in smaller cavities, but larger cavities require so much tissue sacrifice that considerable deformity may result. According to Behrend, chronic empyema patients are

poor surgical risks and the Schede operation is so formidable that the mortality rate in the best hands was at a prohibitive 50 per cent.

Pedicle muscle "fills" for chronic cavities were recommended by Kirschner in 1921, and have been used quite uniformly since. Carter finds them very adaptable in large chronic cavities under the scapula or at the apex of the thoracic cage. Additional conservation of rib is obtained by their use. Such transplants are only successful in relatively clean cavities, and are not used in the first stage of any operation. Care is taken to sew the muscle into the apex of the cavity, to prevent residual pockets and give the muscle a new insertion. In bronchial fistula, a portion of the graft is sewn directly into the fistula opening.

Three unroofing operations of short duration are preferable to one prolonged one. Empyema cavities decrease remarkably in size from one stage to the next, so that the ultimate amount of rib removal is less following operation in stages.

Behrend has successfully combined selective partial thoracoplasty of the modified Schede type with subsequent pedicle grafts. Chronic empyema patients require very careful preoperative preparation, as they have suffered a long, debilitating illness and require numerous blood transfusions and a high caloric and high vitamin diet to improve their nutrition.

#### PUTRID EMPYEMA

Neuhof and Hirshfield show that putrid empyema is a pathological entity deserving separate consideration. Effective treatment depends upon thorough knowledge of its pathogenesis, pathology, and clinical manifestations.

The contents of a putrid empyema abscess cavity consist of foul pus and detritus gathered in one or more compartments. Foul air is often present, depending upon the size and patency of the bronchial communication at the site of the rupture of the abscess of the lung. Although the

bacteria are anaerobic the organisms are not gas-producing in the abscess or in the complicating empyema. A putrid empyema, therefore, may contain no air if the pulmonary abscess from which it is derived is shut off from its bronchus.

The lining of the cavity is intensely inflamed, hemorrhagic, and not infrequently gangrenous. The mediastinum is usually fixed very early by visceroparietal pleural adhesions regardless of the amount of pus. As a result, marked shifting of the mediastinum is rarely seen. There is dense fibrous formation of adhesions in aerobic empyema, while the anaerobic organisms have a liquefying effect on the suppurative process. For this reason there is an ever present danger of an encapsulated putrid empyema escaping into the general pleural space.

Neuhof and Hirshfield believe that recognition in acute cases may be difficult until foul pus is aspirated. The onset and course closely resemble pneumonia but the pain is localized and constant. The sputum is scanty or absent and not blood-streaked. If foul sputum or foul odor is present, the diagnosis is established. In cases of putrid empyema without evident previous intrapulmonary suppuration and without foul sputum the diagnosis is often delayed. The physical signs may early suggest presence of pleural fluid. Roentgenograms are essential to demonstrate fluid, and to locate the site for exploratory aspiration. The typical film of air and fluid in the pleura is seen only when there is free bronchopleural communication. Displacement of the heart and mediastinum is rarely seen in the roentgenogram because of their early fixation. The film may show multiple encapsulations of fluid or fluid and air. Knowledge of two or more pleural loculations is an invaluable guide in treatment.

Following disclosure of foul pus or foul air, operation should be immediately performed, since nothing can be gained by delay and after the aspiration of foul pus there is possibility of putrid phlegmon developing in the chest wall. This usually

dissects between the ribs and intercostal muscles and may not be recognized for several days. Maier and Grace have seen it within twenty-four hours. Necrosis of the muscles and osteomyelitis of the ribs may be found. The needle should be left in place when at all feasible so as to prevent an abscess of the chest wall and to open down onto the putrid abscess.

Immediate improvement is seen after evacuation, ventilation, and aeration of an anaerobic infection. Neuhof and Hirshfield believe that the essentials of operative treatment are complete evacuation of pus, adequate aeration, and adequate care of residual lesions in the lung and pleura. Wide unroofing, allowing full visualization of the cavity, is imperative, in order that drainage may be maintained to the bronchial fistula and for better drainage of the pulmonary abscess.

Rib resection should be just short of the limits of the lesion to prevent entry into the uninvolved portion of the pleural space. The cavity and all its recesses are then packed with iodoform gauze or zinc peroxide, as advocated by Johnson and Meleney.

Postoperative improvement is dramatic. If a toxic state has existed it is usually gone within twelve to twenty-four hours. Pain, dyspnea, rapid heart action, and fever quickly subside. Cough, if present before operation, immediately stops.

The bronchopleural fistula must be maintained and not allowed to close prematurely; otherwise all the symptoms of putrid abscess of the lung may return.

Interlobar putrid empyema is fortunately very rare. There is a close resemblance between interlobar empyema and an unruptured abscess of the lung facing the interlobar fissure. The operation must be frequently carried out in two stages: the first, wide isolation by packings to seal the general pleural cavity completely, and the next, entering the empyema cavity.

Closed drainage can be justified in putrid empyema only because of the danger of open operation when the mediastinum is

mobile. A basic objection to closed drainage is its inability to eradicate the anaerobic infection without free ventilation.

The mortality rate need not be high if there are early recognition, accurate diagnosis, and immediate treatment. Immediate open drainage gives best results. All less radical methods give unreasonably high mortality rates.

#### ANALYSIS OF CASES

One hundred sixty-nine patients with non-tuberculous thoracic empyema have been treated at the Guthrie Clinic and Robert Packer Hospital since 1927, under supervision of a thoracic surgeon, and with strict adherence to the principles laid down by the Empyema Commission.

Recognizing that children are much less tolerant of chest surgery than adults, the study has been carried out in two groupings: patients twelve years of age and under and those over twelve.

There were eleven fatalities, an over-all mortality rate of 6.5 per cent. In seventy-eight patients over twelve years there were eight deaths, bringing the rate to 10.25 per cent. In the group twelve years of age and under there was one death in eighty-one patients, a mortality rate of 1.2 per cent. There were nine cases of putrid empyema in the group over twelve, with a mortality rate of two, or 22 per cent.

In the first five-year period from 1927 to 1931, during which forty-two patients were treated, there was a mortality rate of 5 per cent in the group over twelve, and no deaths in the group twelve years of age and under. In the next five-year period from 1932 to 1936, there was a mortality rate of 2.8 in the group twelve years of age and under, and a rate of 11.8 per cent in those over twelve. There was complete recovery of two cases of putrid empyema. In the last five-year period from 1937 to 1941, there were twenty-four patients over twelve years of age with three deaths, a mortality rate of 12.5 per cent. There were no deaths in twenty-three patients twelve years of age and under. There were

five cases of putrid empyema during this period, all in the group over twelve years of age. Two deaths made a mortality rate of 40 per cent, the only increase in these periods. During 1942 there were three cases of putrid empyema in the group over twelve, with no deaths.

Chronic empyema cases required 95.2 average hospital days. One putrid empyema patient over twelve required seventy-four days. Patients having a mixed type of empyema, pneumococcal and streptococcal, all over twelve, required 46.67 average hospital days. We believe these figures represent a good average.

The mixed type of empyema caused by streptococcic and pneumococcic organisms had an average duration of illness prior to operation of 18.5 days, while the pneumococcic empyema required 24.66 days for patients twelve years of age and under and 23.26 days for those over twelve. The streptococcic type twelve years of age and under was not operated until 54.67 days, and 45.23 days for the group over twelve. Chronic empyema in twenty patients over twelve required 96.7 days. Five putrid empyema patients over twelve, in which the streptococcus was the predominating organism, required 55.6 days. These figures substantiate the statement that fixation of the mediastinum and stabilization of the diaphragm require a much longer time in streptococcal empyema than in the pneumococcal type.

There were twenty-five chronic empyema patients, twenty over twelve years.

There were 105 males, forty-six of them twelve years and under, and fifty-nine over twelve. Thirty-six females were twelve years and under and twenty-eight over twelve, a total of sixty-four.

Eighty-one patients were twelve years of age and under, the youngest being five months, the average age 5.54 years. Seventy-eight varied from thirteen to eighty-one years, the average 39.76. There was one case of putrid empyema six years of age and nine cases from twenty to sixty-nine years.

Distribution of sides involved was nearly equal, the right being the focus of infection in eighty-two cases and the left in eighty-three. Both sides were involved in four patients.

The pneumococcus was the etiological organism 124 times, a percentage of 73.4; the streptococcus thirty-five times, 20 per cent; the staphylococcus 3 per cent, the albus in four instances and the aureus in two. Combinations of other organisms were responsible for the rest.

Seven cases had the etiology out of the chest: suprapubic prostatectomy, one case, acute appendicitis three, lung abscess and subdiaphragmatic abscess one, and brain abscess one.

Predisposing causes of putrid empyema were: Undetermined three, lung abscess three, bronchopleural fistula one, bronchiectasis two, lung abscess secondary to generalized peritonitis from ruptured appendix one, and questionable carcinoma of the lung and abscess of chest wall one.

Types of empyema as revealed by roentgenograms and surgery were: encapsulated fifty-seven, putrid ten, diffuse twenty-seven, loculated six, multilocular five, massive nine, encysted one, and undetermined five.

Empyema being a prolonged illness, it is reasonable to expect complications to arise rather frequently. There was a total of thirty-two complications in twenty-nine patients. A case of purulent pericarditis resulted fatally. Otitis media, the most common complication, was seen in six patients.

Differentiation between complications and associated conditions requires most astute judgment. Fifty-five associated conditions were seen. Otitis media was noted eleven times. Varicella was next in frequency, being seen four times.

Roentgenograms were taken to establish diagnosis or confirm it in all cases. Diagnostic aspiration was then made to establish presence of fluid and identify the type of etiology.

The three recognized forms of treatment: aspiration, intercostal closed drainage, and rib resection with or without open drainage, were employed.

Local anesthesia of 1 per cent novocaine was given for all aspirations.

Four patients recovered with repeated aspirations, ranging from five to seven. The findings from this limited group indicate that we cannot share the opinion of others who believe that many patients may be cured by aspiration alone.

Thirty-five patients received closed thoracotomy following therapeutic aspiration, ranging from one to eleven. Two patients died, one ninety-seven days and the other thirty-four days after operation. Two patients had persistent coughs at the time of their recent check-up. The result in two patients was unknown and the rest were cured. Twenty-five of these patients were twelve years of age or under and the other ten were over twelve. These results prove that closed intercostal drainage is most useful in the younger group.

An equal number of patients twelve years of age and under and over twelve years required aspiration, closed thoracotomy, and rib resection for complete cure. Four patients with putrid empyema received the same treatment. One patient had a partial thoracoplasty and still has a residual cavity requiring further surgery. Two thoracoplasties were done, one with complete recovery, the other still has a residual cavity.

Rib resections with previous aspirations, carried out on ninety-one patients, resulted in eight fatalities, two of them putrid empyema cases, two unknown, and eighty-one complete cures. Four cases of putrid empyema were cured by wide rib resection. Only three patients were treated in a closed manner after resection.

In the first five-year period from 1927 to 1931, the Willy Meyer-Pickhardt operation was carried out on eight patients with complete recovery in every case. It has been discontinued.

Dependent drainage of thoracic empy-

ema cases has been stressed. The rib to be resected was determined by the location of the cavity; the eighth rib being resected fifty-two times, the ninth thirty-four times, and the seventh twelve times, and various combinations.

Empyema of the lung is a prolonged debilitating infection which produces many complications requiring operative procedures. Otitis media is frequent in childhood. Seven patients required myringotomy, one case having one side involved and the rest both sides. One radical mastoidectomy was done. Curettement of old sinus tracts to the empyema cavity was done with seven patients. Three appendectomies were performed for acute gangrenous perforated appendicitis, producing an ascending infection which led to the thoracic empyema. A gun shot wound of the chest and abdomen required a splenectomy. Six patients had bronchoscopic examinations. One subdiaphragmatic abscess of unknown etiology was drained. A thirty-two year old woman had a nephrectomy for a marked hydro-nephrosis, complicated by a retroperitoneal abscess which dissected upward producing the empyema. One pelvic abscess secondary to a ruptured appendix was drained by vaginal route. A suprapubic prostatectomy was complicated by a massive infected pleural effusion. The thoracic cavity was explored in four patients, a biopsy being taken during one of the procedures. An abscess of the hip was incised and drained. An abdominal exploration of one patient revealed a pneumococcic peritonitis requiring transthoracic exploration of the right subdiaphragmatic space followed by a pericardicentesis, with complete recovery. Four patients had complicating abscesses of the breast requiring drainage. There was one carbuncle of the neck.

All therapeutic aspirations were carried out under local anesthesia. Ethylene was used in most rib resections and thoracoplasties until the last four years, since which time cyclopropane has been used in all cases except patients with cardiac lesions.

Sulfonamide therapy was used with some patients, mostly by the family physician before they arrived at the hospital, and it is difficult to evaluate the results. It has a beneficial effect in lowering mortality rates, but it has not appreciably altered the development of empyema cases.

Figures illustrating the technical points and four roentgenograms representing the various types of empyema are included.

#### SUMMARY AND CONCLUSIONS

The subject of non-tuberculous thoracic empyema has been considered and the more recent literature reviewed.

The study of 169 cases of non-tuberculous thoracic empyema with eleven deaths is quite comparable to other recently reported series.

The mortality rate of 6.5 per cent is recorded.

The cases have been divided into two groups for study; one group comprises those patients twelve years of age and under and the second group over twelve years of age.

The cases have been studied in three five-year series. There is very little difference in the mortality rate for these periods except in the last five-year period when the mortality rate for putrid empyema cases increased to 40 per cent.

One hundred five males and sixty-four females had thoracic empyema.

There were eighty-two cases with right side involvement and eighty-three with left side involvement. Four patients had both sides involved.

Pneumococcus, which was the most frequent organism found, was responsible for 73 per cent of the thoracic empyema cases. The streptococcus was responsible in 20 per cent of the cases and the staphylococcus in 3 per cent. The other types of organisms were responsible for the remaining empyema cases.

There were nine cases of putrid empyema.

Otitis media was the most frequent complication and associated condition.

Treatment consisted of various operative

procedures. Aspiration with subsequent rib resection and open drainage was carried out ninety-one times. Thirty-seven patients received aspiration, and closed intercostal drainage followed by open rib resection.

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# THE EFFECTS OF SULFANILAMIDE LOCALLY IMPLANTED IN CLEAN WOUNDS

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ARTICLES in the surgical literature from time to time refer to the sulfonamide drugs and their influence on healing of wounds when locally applied, but there seems to be lack of uniformity of opinion as to what influence they do exert. Key,<sup>1</sup> from animal experiments and observation of clinical cases, believes that healing is not at all delayed. Taylor<sup>2</sup> deplors the local use of sulfonamide drugs because he states they produce marked inflammatory reaction, and indicates that he believes healing is disturbed. Klepser's<sup>3</sup> observations led him to believe that prolonged use of these drugs locally may interfere with healing in granulating wounds, but he observes that the question of wound healing in the presence of sulfonamide drugs is unsettled. Bick,<sup>4</sup> from his study of use of the drug in clean and traumatic wounds, concluded that healing was delayed 50 per cent, but later indicated<sup>5</sup> that he might have been using too much drug in his earlier work and expresses the opinion that its use should be continued in contaminated wounds. Lyons and Burbank<sup>6</sup> in reviewing this subject in 1942 stated: "There is striking lack of critical evidence in regard to the effect of locally implanted sulfonamides in wound healing. . . . Further experimental evidence must be available before the effect on wound healing can be properly evaluated."

In an effort to help clarify this question, a study was undertaken to determine the effect of local sulfanilamide implantation in clean wounds. Patients with bilateral inguinal hernias were selected as subjects. Through two separate inguinal incisions,

the routine hernioplasty of the hospital was performed at one sitting. In the operation used, the layers are sewed with interrupted catgut stitches. The wounds usually heal by first intention but with some firmness of the scar. For the purpose of this study, sulfanilamide powder was placed in one side and omitted in the other. All patients on the author's division of the general surgical service coming to operation for bilateral inguinal hernia, suitable for bilateral operation at one time, were included. In all, 304 patients were operated upon for inguinal hernia on this division during the year 1943, the period covered by this study. Of these, thirty-seven had bilateral hernias suitable for operation at one time and all of these are reported. Sulfanilamide was placed in the left repair and omitted in the right. Five Gm. of drug were used and this was spread evenly through all layers of the wound. In eleven patients, unsterile crystalline sulfanilamide was used; in fourteen others, sterile drug was employed. To serve as further controls, no drug was used on either side in twelve patients. Observations were begun on the fourth postoperative day and continued to the twenty-second postoperative day. All operations and observations were made by the writer. Observations were made by physical examination. Possibly the value of this study would have been increased by microscopic study of the wounds, but it was not thought practicable to excise sections. The results are listed in the accompanying tables.

Discoloration of the skin was an almost constant feature of treated sides, being

\* From the United States Public Health Service, Marine Hospital, Stapleton, Staten Island, N. Y. By permission of the Surgeon General.

present in twenty-one of twenty-five cases. This consisted of a blue or purple tinge characteristic of hemorrhage. In some, this

able pain in his operative wound throughout his hospital stay, but this was in a right (untreated) side. Little difference

TABLE I  
EFFECTS OF UNSTERILE\* SULFONILAMIDE POWDER IN LEFT WOUNDS

Case Designation	Date	Discoloration†	Induration	Infection	Healing
1. TG 110109	1/15/43	R none L 2 plus to 14th day	equal	none	satisfactory
2. HW 110346	1/20/43	R none L 1 plus to 7th day	equal	serum pocket on left	satisfactory
3. GS 110601	1/29/43	R none L 2 plus to 10th day	equal	none	satisfactory
5. SB 111610	2/19/43	R none L 4 plus to 22nd day	equal	none	satisfactory
9. RM 112808	3/22/43	R none L 4 plus to 22nd day	equal	none	satisfactory
10. AB 113123	3/26/43	R none L 4 plus to 22nd day	slightly greater on left	none	satisfactory
12. CF 113791	4/12/43	R none L 4 plus to 22nd day	equal	none	satisfactory
13. WM 113956	4/14/43	R none L 2 plus to 14th day	about 1/4 greater on left	none	satisfactory
15. LJ 114716	5/5/43	R none L 1 plus to 8th day	equal	none	satisfactory
17. JC 115034	5/10/43	R none L 3 plus to 14th day	equal	none	satisfactory
19. FL 116414	6/14/43	R none L 1 plus to 10th day	equal	none	satisfactory

\* This product had once been sterilized but was not kept in sterile packets. † Discoloration in all tables is graded roughly from one plus to four plus according to extent of area involved. The day mentioned is the post-operative day on which discoloration was noted to have disappeared.

change was noted only directly adjacent to the wound. In others, it extended from the wound edge for a distance of 10 inches in all directions. No distinct tumefaction accompanied this discoloration, that is, hematomas did not form. No collections of free blood were found. The consistency of the skin and subcutaneous tissue was the same in treated and untreated sides with the exceptions noted below. This indicates that hemorrhage occurred by diapedesis, probably through vessels made more permeable by the drug. Discoloration sometimes persisted until the twenty-second day. At first dark in color, the pigmented areas later became yellow and pallid and in some faded entirely. Discoloration was in no instance associated with increased pain or abnormal tenderness. One patient, No. 32 in Table II, complained of consider-

could be detected in the actions of sterile and unsterile powder. We have not noted this type of hemorrhage in these wounds in the past and none of the control sides or control patients in this series showed it. An occasional patient in whom this drug was used in a right rectus incision, after appendicectomy for gangrene of that organ, showed similar changes in skin color. It is concluded that this hemorrhage is directly attributable to the action of sulfanilamide locally applied.

The wounds were observed for differences in thickness and induration of the scar. Five patients had differences, the treated sides showing increase. Induration, as observed previously and in the controls of this series, consists of diffuse thickening of the scar as healing progresses. Differences in scar thickness that were readily

detectable by palpation were counted. As far as can be determined, the same factors were present in both wounds on the same wound. It was opened, the fluid evacuated and cultured. The culture gave no growth. This pocket was closed by strapping with

TABLE II  
EFFECTS OF STERILE SULFONILAMIDE POWDER IN LEFT WOUNDS

Case Designation	Date	Discoloration	Induration	Infection	Healing
20. JM 116501	6/14/43	R none L slight	equal	none	satisfactory
22. FK 117575	7/9/43	R none L none	slightly greater on left	none	satisfactory
24. SC 119272	8/20/43	R none L 2 plus to 8th day	equal	none	satisfactory
25. IS 120686	9/22/43	R none L none	equal	none	satisfactory
26. AS 12129	10/15/43	R none L 2 plus to 10th day	equal	none	satisfactory
27. EN 121733	10/17/43	R none L 1 plus to 14th day	equal	none	satisfactory
28. DS 122438	10/29/43	R none L none	equal	none	satisfactory
29. EM 122660	11/3/43	R none L 1 plus to 12th day	equal	none	satisfactory
31. NL 123220	11/17/43	R none L none	equal	none	satisfactory
32. JC 123802	11/20/43	R none L 2 plus to 22nd day	50% greater on left	none	satisfactory
33. EB 123603	11/26/43	R none L 4 plus to 14th day	equal	none	satisfactory
35. AH 123692	11/26/43	R none L 1 plus to 12th day	equal	none	satisfactory
36. MG 124263	12/10/43	R none L 2 plus to 14th day	slightly greater on left	none	satisfactory
37. JD 124323	12/12/43	R none L 1 plus to 7th day	equal	none	satisfactory

patient with the exception of sulfanilamide in the left side; and it seems reasonable to attribute increased scar thickness in these five patients to action of the drug, as no inequalities of scar formation were noted in patients having no drug in either side.

The wounds were observed for infection. Of the 304 inguinal hernioplasties performed on this division in 1943, purulent infection occurred in two. Sterile serum pockets in the wound occurred in three others. None of the patients in the bilateral series had purulent infection. One had a serum pocket (Case No. 2, Table 1). This occurred on a left side in which unsterile sulfanilamide had been employed. On the sixth postoperative day, a soft tumor 1 cm. in diameter was found in the center of the

flamed adhesive plaster and it healed without further drainage. It is not believed that this serum pocket was caused by application of unsterile sulfanilamide. No other disturbances of the wounds were noted. Excessive serum did not form in any, and with the exception noted above none had drainage of any kind.

The progress of healing was observed clinically. Upon removal of skin sutures on the fourth day, the skin edges were adherent as usual. The presence of discoloration did not appear to influence healing at any stage. On the twenty-second day a final observation on healing was made. In every instance it was satisfactory. The repairs were strong and early induration of the wounds was beginning to absorb. The

TABLE III  
CONTROL GROUP IN WHICH NO DRUG WAS USED

Case Designation	Date	Discoloration	Induration	Infection	Healing
4. CC 110949	2/8/43	R none L none	equal	none	satisfactory
6. EW 111920	2/24/43	R none L none	equal	none	satisfactory
7. TM 111898	2/24/43	R none L none	equal	none	satisfactory
8. AH 112199	3/3/43	R none L none	equal	none	satisfactory
11. LS 113678	4/9/43	R none L none	equal	none	satisfactory
14. RZ 114677	5/3/43	R none L none	equal	none	satisfactory
16. EE 114724	5/6/43	R none L none	equal	none	satisfactory
18. EG 116321	6/11/43	R none L none	equal	none	satisfactory
21. WS 116880	6/23/43	R none L none	equal	none	satisfactory
23. BK 117953	7/21/43	R none L none	equal	none	satisfactory
30. ES 122675	11/5/43	R none L none	equal	none	satisfactory
34. FO 123702	11/26/43	R none L none	equal	none	satisfactory

usual hairline incisions of primary union were present. There were no immediate recurrences and no induration, atrophy, or edema of the testicles or cords. When extensive discoloration had been present, it was beginning to fade, leaving in some cases a faint yellow tinge. Inequalities of induration were beginning to disappear. No differences in healing could be detected by physical examination.

From this study it appears that sulfanilamide in inguinal hernioplasty wounds, done by a catgut technic, frequently produces hemorrhage into the wound and surrounding tissues, sometimes produces increased induration of the wound, but has

no effect on healing as determined by physical examination.

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# IMPROVED TECHNIC FOR PREPARING A BURIED DERMAL GRAFT IN HERNIAL REPAIR

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THE use of a buried dermal graft is not new. Rehn<sup>1</sup> reported using dermal grafts for repairing a hernia back in 1941. Strassma<sup>2</sup> used buried dermal grafts to repair saddle nose. It has also been used to repair cranial defects.<sup>3,4</sup> Cannaday<sup>4</sup> reports its successful use in thirty-seven cases which included hernias (incisional and inguinal), fixation of uterine cervix to rectus aponeurosis for prolapsed uterus, to hold in position an osteoperiosteal graft and to replace fibular collateral ligament in acromioclavicular separation.

Peer<sup>3</sup> investigated the fate of buried dermal grafts. He buried grafts beneath the skin of the chest in humans and removed them at intervals ranging from one week to one year. Examination showed all sebaceous glands and hair follicles had completely disappeared. Sweat glands were present at the end of one year but showed definite degenerative changes. When the epidermis was incompletely removed small cysts developed but later these disappeared.

While this article was being prepared Swenson and Harkins<sup>5</sup> published a report summarizing the literature on this subject and described their technic for preparing the dermal graft. Their graft is of the same type as the one to be described, has the same advantages, but its preparation is technically more difficult, and it has the disadvantage of varying in thickness.

As far as I can determine from the literature, buried dermal grafts have "taken" successfully in almost all cases. Since the viability of any graft in the body depends directly upon its ability to secure an adequate blood supply from the nearby tissues, certain situations can arise which, theoretically at least, make a successful "take" appear to be hazardous when the

usual technic is applied. This technic first is to denude the skin of the epidermal layer. Then the derma is cut away, making the graft of any desired size. This derma has subcutaneous fat attached to it, or if this is removed, the fibrous tissue at the base of the skin is attached to the graft. This subcutaneous fat or fibrous tissue on the undersurface of the skin offers a poor surface for a successful "take." The opposite side of the skin, however, (where the epidermal layer was removed) is an excellent surface for a successful "take." If the graft could be prepared so that both sides can take equally well, the chances of its viability are immediately doubled. It is the purpose of this paper to describe such a method.

Often in repairing a large ventral hernia (with a fascial defect so that the fascia cannot be approximated), the peritoneal closure leaves a very rough floor, with small pockets surrounded by dense fibrous tissue caused by remnants of the fascia. This uneven base does not appear to be the ideal site for a graft since there are small areas of the graft not in contact with the preperitoneal tissues, and the small pockets could collect serum and so deprive the graft of some nourishment. However, if the graft had two sides from which it could get a blood supply, the above mentioned difficulties would be overcome. The following technique has been used successfully on five patients:

Preoperatively the thickness of the skin where the dermal graft is to be taken is roughly determined by gently pinching the skin. This is not difficult to do after trying it a few times. The peritoneum of the hernia is closed as usual and the fascial defect is measured. A dermal graft some-

what larger than the defect should be used.

Now the Padgett dermatome is set to

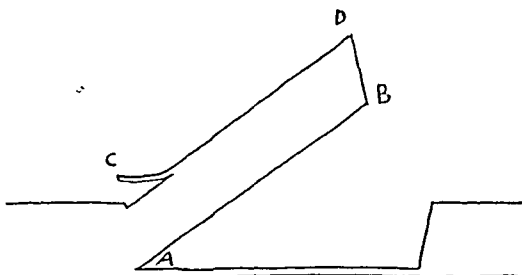


FIG. 1. This figure represents the full thickness of skin. Subcutaneous tissue is not shown. The first cut with the dermatome is from B to A, thus raising the almost full thickness skin flap as shown. The dermatome is now removed, set to cut a thin layer of skin (not over .008) and the cut is made from C to B as shown. The graft is now removed by cutting across at A.

cut a graft just short of the full thickness of the skin, thus leaving a very thin layer of epithelial cells on the donor site. This cut is usually between .04 to .05 inches, so insuring a good thick graft. This graft is left attached at one end (A) as shown, cutting from (B) to (A).

The dermatome is now removed and reset to cut a very thin graft to remove the epidermal layer. This cut need not be over .008 inches (if the shellac used for the dermatome is made quite thin) and is made by cutting from C to D. Allis forceps are used to spread the graft until it is stuck to the drum of the dermatome. When the dermatome is used for the second cut, the old shellac must be removed from the drum and new shellac applied to the drum and skin. The old shellac need not be removed from the skin.

The dermal graft is now removed by cutting it across at A. The graft is sutured to good fascia surrounding the defect, using interrupted silk sutures. A very light sprinkling of sulfanilamide powder may be applied over the graft if desired. The subcutaneous tissues are approximated over the graft, obliterating all dead spaces. The site where the graft was taken is covered with vaseline gauze and left undisturbed for seven to ten days.

Postoperatively these patients were kept in bed for about two weeks. Cannaday<sup>4</sup> reports he allows his patients out of bed on their first postoperative day.

#### CASE REPORTS

CASE I. No. 182267, F. D., white, male, age fifty-two, was admitted to the Fillmore Hospital on March 1, 1943, with recurrent inguinal hernias. His first operation was about three years ago. Two years ago the right hernia recurred and one year ago the left hernia recurred. He was operated upon March 2, 1943. The hernial defect was opposite the left internal ring and the fascia was greatly thinned out. The edges of the thinned out conjoined tendon and fascia of the internal oblique were sutured to the shelving portion of the inguinal ligament but it was obvious these structures were too weak to hold. Therefore, a dermal graft was taken from the right thigh and sutured to the shelving portion of the left inguinal ligament and to firm fascia of the internal oblique. The right hernia was repaired by the usual Bassini technique since the structures on this side appeared sufficiently strong. He was allowed out of bed on March 13th. About four months after his discharge the hernia on the right side recurred (dermal graft not used on this side). The left repair appeared very strong. The patient was reoperated upon December 29, 1943, at which time a buried dermal graft was used to repair the right side.

CASE II. No. 186016, I. S., white, male, age forty-two, was admitted to the Millard Fillmore Hospital on May 26, 1943. He had a right inguinal herniorrhaphy. Following this he had an appendectomy. Then he had another herniorrhaphy for a recurrence of the right inguinal hernia. Later he had a third herniorrhaphy for a recurrence. When seen at this hospital on May 26th, his inguinal hernia extended to and included a bulge in McBurney's area. On May 31, 1943, he was operated upon for the fourth time. It was found that at his previous operation the fascia of the sheath of the rectus muscle had been used for the repair. The hernial sac extended from the pubic tubercle to McBurney's point. The hernial sac was excised and the peritoneum closed. The fascia present was too thinned and shredded to be considered useful for support. A dermal graft was then taken from the thigh and sutured to the remnants of the inguinal

ligament and to firm fascia of the internal and external oblique muscles. This operation was facilitated by removing the atrophic testicle. Since his discharge on June 14, 1943, he has had no signs of recurrence.

CASE III. No. 190531, D. O., white, male, age sixty-two, was admitted to the Millard Fillmore Hospital on September 2, 1943, with a postoperative hernia following a cholecystostomy four months ago for a ruptured gallbladder. He was jaundiced on admission and his history fit in with a stone in the common duct. He was operated upon on September 7, 1943, at which time two large stones were removed from the distal end of the common duct, a T tube inserted in the duct, the gallbladder removed and the drain and T tube brought out through a stab wound in the side. The peritoneum was then closed but the fascia could not be closed over an area 3 inches long by  $1\frac{1}{2}$  inches wide. A dermal graft was then taken from the edge of the skin incision and sutured to the anterior surface of the sheath of the rectus muscle. He was allowed out of bed on September 23rd and to date has had no signs of recurrence of his hernia.

CASE IV. No. 192506, V. B., white, female, age thirty-seven, was admitted to the Millard Fillmore Hospital on October 18, 1943. She had had a gallbladder operation in 1938. In 1941, when seven months pregnant, she developed an intestinal obstruction and was operated upon through a supra-umbilical midline incision, following which she developed pneumonia. During the course of her pneumonia she developed an incisional hernia. At operation on October 20th, her fascia was adequate to cover the hernial opening but it appeared wise to reinforce it with a dermal

graft taken from the left thigh. Since her discharge on November 5th, her wound has remained very firm.

CASE V. 193301, R. S., white, female, age thirty-four, was admitted to the Millard Fillmore Hospital on November 7, 1943. She was extremely obese. Five years ago she had a pelvic laparotomy following which she developed pneumonia and a resulting incisional hernia. Three years ago when she had an acute intestinal obstruction, she was operated upon, the obstruction relieved, but it was impossible to close the fascia. Since then she has been hospitalized three times for intestinal obstruction but not operated upon. At operation on November 8, 1943, her fascia could not be closed over an area about  $2\frac{1}{2}$  inches by 6 inches. A dermal graft was therefore taken from the upper left abdomen and sutured in place. She again developed a pneumonia postoperatively and was discharged symptom free on November 21st, by ambulance. Repeated careful examinations have not shown any signs of recurrence.

#### SUMMARY

An improved technic for preparing a buried dermal graft for hernial repair is described. A series of five cases is reported in four of which there was either no fascia to approximate or the fascia was too thin and frayed to be used for repairing.

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# Case Reports

## SEVERE OSTEITIS FIBROSA CYSTICA WITH PARATHYROID TUMOR

REPORT OF A CASE OF FIFTEEN YEARS' DURATION

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**H**YPERPARATHYROIDISM due to parathyroid adenoma is one of the few diseases the evolution of which from unrelated clinical symptoms to a definite diagnostic reality has been completed within the time of the present medical generation. Granted that the disease is rare, the fact still remains that the disease is not recognized in the majority of cases until late in its course when bone deformities are present. A review of the reported cases to date shows an estimated duration of approximately four years between the onset of symptoms and the diagnosis of the disease. This fact is regrettable inasmuch as there are few diseases that lend themselves to such brilliant recoveries when diagnosed early and treated properly.

The delay in the recognition of the disease can probably be subscribed in part to its rapid evolution which has prevented the syndrome as such from being taught except to graduates in the last ten years. Another contributing factor is that the disease, until lately, required a considerable amount of laboratory study for its diagnosis, such work often being beyond the scope of smaller hospital and clinic laboratories.

The present case emphasizes the delay in the recognition of the disease inasmuch as the patient's symptoms dated back over a period of fifteen years, during which time she had suffered from nephrolithiasis and no less than four fractures. This case is reported to emphasize the necessity of keeping the disease before the profession, especially so in these days when so many of the younger men are in

the armed forces and the task of diagnosis often rests with the older group of physicians.

### CASE REPORT

Mrs. N. S., American, aged sixty, was admitted to the hospital in July, 1943, complaining of severe pain in her right hip radiating down the posterior aspect of her right thigh, of six months' duration. During this time she had become progressively shorter in stature, had worn a Taylor brace to support her back and walked with difficulty with the aid of crutches. Her past history was interesting in that during 1928 she fell and fractured her right knee cap. In 1933, she had several attacks of right renal colic with hematuria and subsequently underwent an operation for the removal of calculi from the right kidney. In 1935, she fractured her right shoulder. In 1941, she sustained a fracture of her left knee cap. In 1942, the year previous to admission, while picking up a small oil can, the weight of which was approximately 4 pounds, she fractured her left shoulder. All fractures healed without incident and although x-rays were taken on each occasion, no mention was made of any unusual bone changes.

During the past year she had noticed a progressive numbness in her legs accompanied by difficulty in walking. Her appetite had remained good, there had been no loss of weight; there had been, however, a marked tendency to constipation.

Her family history was not remarkable except for the death of one child at seventeen years of age of bone sarcoma.

Physical examination showed a pale, well nourished, middle-aged white female lying quietly in bed, her torso sharply twisted to the right. Her features were coarse and puffy, the skin was dry and subicteric, and the hair was distinctly dry and brittle. The mouth was edentulous. The gums were healthy and showed no evidence of tumor.

The thyroid was not enlarged. There was a questionable fullness, however, opposite the lower pole of the gland on the right. No definite mass could be demonstrated. There was no cervical adenopathy.

The entire left side of the chest was compressed and flattened toward the right to produce a modified pigeon breast deformity. The right side of the chest flared, rib spaces were prominent and respiratory excursion on this side was nearly normal. The heart was not enlarged. Blood pressure was 128/84; rhythm was regular; sounds normal. The peripheral arteries showed sclerosis grade 1.

The spine was more or less rigid with a prominent dorsal kyphosis with an accompanying right roterolateral dorsal scoliosis. The patient was unable to sit up without support.

Motions at both shoulder joints were normal. Motion in the right hip was painful and markedly restricted in all directions. There were well healed non-tender operative scars in the right loin and over the anterior surfaces of both knee joints. Reflexes were sluggish; cutaneous sensation was normal.

X-ray examination showed an extensive pathological process involving the skull, spine, ribs, pelvis and bones of the extremities. In the skull the process was characterized by marked thickening of the calvaria, the bones of the vault having a fine, mottled, granular appearance. The maxillary antra and sphenoidal sinuses appeared to be enlarged.

In the upper extremities the process was characterized by areas of absorption with cyst formation in the upper ends of both humeri, the left ulna, in the right radius, the right os magnum, the third left metacarpal, and in the proximal phalanx of the right first and the left second fingers, respectively. The site of the previous fracture in the right humerus could be easily demonstrated.

In the lower extremities the entire upper two-thirds of the right femur was a mass of thin-walled cystic cavities completely replacing the normal bone structure. The overlying cortex was extremely thin and somewhat expanded. Cysts were also present in the right tibia, the left tibia, both patellas, and in the first left metatarsal.

A film of the abdomen showed numerous areas of increased density in both kidney regions consistent with the diagnosis of nephrocalcinosis.

Films of the pelvis showed extensive involvement of both innominate bones with com-

pression and distortion of the entire left half of the pelvis upward and inward to create a typical oblique deformity. There were large cystic areas of bone destruction in the region of the right acetabulum and right ilium.

The ribs showed multiple areas of cystic formation, more marked in the left seventh and eighth ribs with a concomitant expansion of their cortex. The vertebrae were extensively involved throughout the entire dorsal region with almost complete loss of substance of the third, fourth, fifth and sixth dorsal vertebrae. There was a well developed dorsal kyphosis, the apex of which was at the seventh dorsal vertebra with an accompanying right roterolateral scoliosis and a compensatory left lumbar scoliosis.

Laboratory findings were as follows: Blood showed a red count of 3,400,000; hemoglobin 74 per cent (Sahli); white count 6,600; polymorphonuclears 53 per cent, lymphocytes 44 per cent, monocytes 3 per cent; basal metabolism + 4 per cent; blood proteins: albumin 4.8 mg.; globulin 2.4 mg.; blood sugar 131 mg.; non-protein nitrogen 33 mg.; serology: Wassermann and Eagle tests negative; blood type O; blood calcium 15 mg.; blood phosphorus 2 mg.; blood phosphatase 26.8 Bodansky units. Urinalysis: Specific gravity 1.018; alkaline, negative to sugar and albumin; sediment negative; Sulkowitch test on urine 4 plus.

The patient's history together with the typical x-ray findings suggested the diagnosis of osteitis fibrosa cystica due to parathyroid adenoma. The elevated blood calcium with a decreased blood phosphorus and markedly increased blood phosphatase confirmed the diagnosis. Operation was advised and readily accepted by the patient.

Under avertin-ether anesthesia a routine collar thyroidectomy incision was made. The pretracheal fascia was opened in the midline. The strap muscles were divided high up on either side between clamps and reflected. Dissection was begun in the region of the right lower pole, the gland being rotated mesially and an apparently normal parathyroid gland was quickly identified lying in the bifurcation of the inferior thyroid artery. The dissection was continued upward and the right superior parathyroid identified. Thorough digital exploration in the region of the inferior pole failed to reveal any evidence of tumor. Accordingly, the left lobe of the thyroid was exposed, the inferior pole vessels were ligated and the gland rotated medially. By careful dissection

both superior and inferior parathyroids were demonstrated clearly and appeared to be normal. It was then realized that the tumor

2 cm. Hemostasis was secured with silk ties throughout. Routine thyroidectomy closure was carried out with no drainage. The patient



FIG. 1.—See legend on opposite page.

lay either in the mediastinum or in the gland substance itself. The right lower pole of the gland was again exposed, rotated upward, inferior pole vessels divided, the fascia overlying the gland posteriorly incised and the dissection carried downward into the superior mediastinum. Here at a distance of approximately 4 cm. from the lower pole of the thyroid on the right a soft, greyish-brown, encapsulated mass typical of parathyroid adenoma was encountered. The mass was approximately the size of a small plum. It was enucleated quite easily, brought up into the wound and found to be attached by a rather long pedicle to the apparently normal right inferior parathyroid gland. The tumor was removed by clamp and ligation. It measured approximately 3.5 by

was given 500 cc. of citrated blood by indirect method with no reaction, and she left the operating room in good condition.

The pathological report was as follows: Macroscopic: The specimen consisted of a mass of greyish-brown tissue measuring 3.5 by 2 by 1.5 cm. The major portion was somewhat heart-shaped with a smooth surface. Projecting from this was an ovoid mass 1 cm. in diameter, which appeared slightly torn. On section the tissue was pale yellowish-grey with a few minute cyst-like structures, and the projecting portion was rather poorly demarcated from a small amount of adjacent fat.

Microscopic: The tissue was covered by a thin capsule, was highly cellular and was divided by a fine reticulum into cords and



FIG. 1. A, extensive moth-eaten appearance of skull; thickening of calvaria; B, granular appearance of vault, enlarged accessory sinuses; C, area of old fracture in head of right humerus; D, cystic areas in shaft and head of left humerus; E, extensive spine involvement with scoliosis, arrows point to areas of nephrocalcinosis; F, extensive involvement of right ilium; oblique distortion of pelvis; G, extensive cystic involvement of right femur, site of postoperative fracture; H, fractured femur six months postoperatively; note remineralization.

small groups of cells in a more or less gland-like arrangement, though few lumina were seen. The cells were generally polyhedral, varying

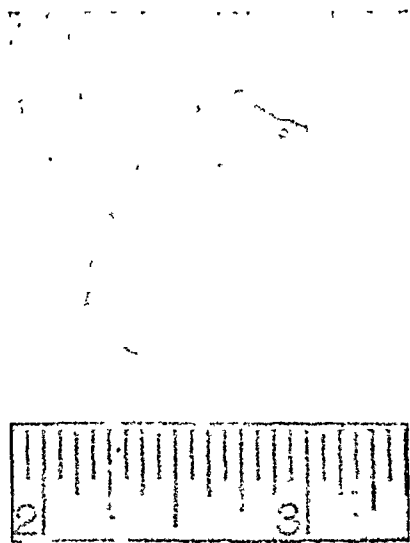


FIG. 2. Gross appearance of tumor on removal.

in size from about 6 to 20 or 25 microns. Some were very light-staining with little or no visible cytoplasm. Others had pinkish or reddish cytoplasm which was more or less granular. Nuclei were fairly large and loose, small and dark, or pyknotic. No mitoses were seen. Cells corresponding fairly well to the four types described by Castleman and Mallory were found, but many intermediate forms suggested that all might be different stages of the same kind of cell. Few scattered follicles were seen, filled with material of colloid appearance, bounded by large, columnar reddish-pink granular cells. Diagnosis lay between hyperplasia and an adenoma. The presence of so-called chief cells in considerable numbers as well as the tendency toward gland formation favored the diagnosis of adenoma.

Diagnosis: Adenoma of parathyroid.

The patient's recovery from the anesthetic was smooth. She received 1,000 cc. 5 per cent glucose in distilled water intravenously. Six hours postoperatively the blood calcium had fallen to 11.42 mg., the blood phosphorus had risen to 4.5 mg.; blood phosphatase was 24.5 Bodansky units.

On her second postoperative day the patient was quite restless; however, she was taking fluids well by mouth and was generally quite

comfortable. She received calcium gluconate by mouth 40 gr. every four hours. Sulkowitch test on urine done on every voided specimen averaged 2 plus.

On her third postoperative day blood calcium was 7.9 mg., phosphorus 3.7 mg., phosphatase 13.7 Bodansky units. She was much more restless. Chevostek's and Trousseau's signs were negative.

On her fourth postoperative day her blood calcium had fallen to 7.37 mg. She had several spells of twitching and trembling which was relieved by intravenous calcium gluconate. Sulkowitch test on urine had been 0 for the previous eighteen hours despite heavy doses of calcium gluconate by mouth and intravenously.

On her fifth postoperative day the patient's total proteins had fallen to 4.56 mg. with almost a complete reversal of the albumin-globulin ratio. Her blood calcium was 9.8 mg., blood phosphorus 2.3 mg. and blood phosphatase 10.16 Bodansky units. Mentally she was extremely nervous and apprehensive. There was no true twitching. Chevostek's and Trousseau's signs were negative. This same day while turning over in bed she felt something snap in her right thigh followed by severe pain in that area. X-rays showed a transverse fracture of the right femur at the junction of the upper and middle thirds through the large cystic area previously described. The fractured femur was reduced by means of the Roger-Anderson technic the following day. Satisfactory reduction was obtained.

Throughout the remainder of her postoperative course her blood calcium and phosphorus continued within normal limits, her blood phosphatase falling to normal and remaining there. (Fig. 4.) On her twenty-sixth postoperative day she was discharged from the hospital, free from pain and walking on crutches. Mentally she was much more alert and her muscular tone had markedly improved so that she was able to support her back without the aid of a brace. Her blood calcium on discharge was 10.5 mg., blood phosphorus was 2.8 mg. and blood phosphatase was 3 Bodansky units. Sulkowitch test on the urine was 3 plus.

She returned to the Clinic for follow-up studies six weeks later at which time her blood calcium was 12 mg., phosphorus 2.57 mg. and phosphatase 2 Bodansky units. Her fracture was in good alignment and there was some callus formation and evidence of beginning

recalcification throughout the entire skeletal system. She had been on a high calcium diet which had contained a good deal of milk and

limbs had begun to fill in, the surrounding cortex being appreciably increased. She had had no pain in this interval. Her mental atti-

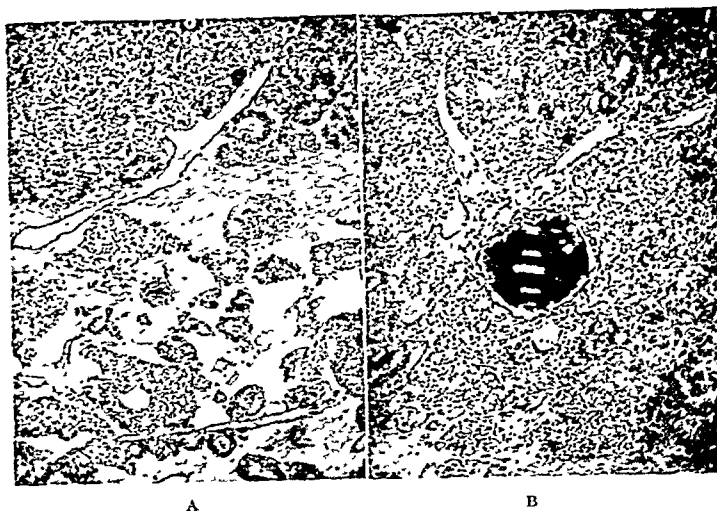


FIG. 3. A and B, microphotographs of tumor showing adenomatous areas.

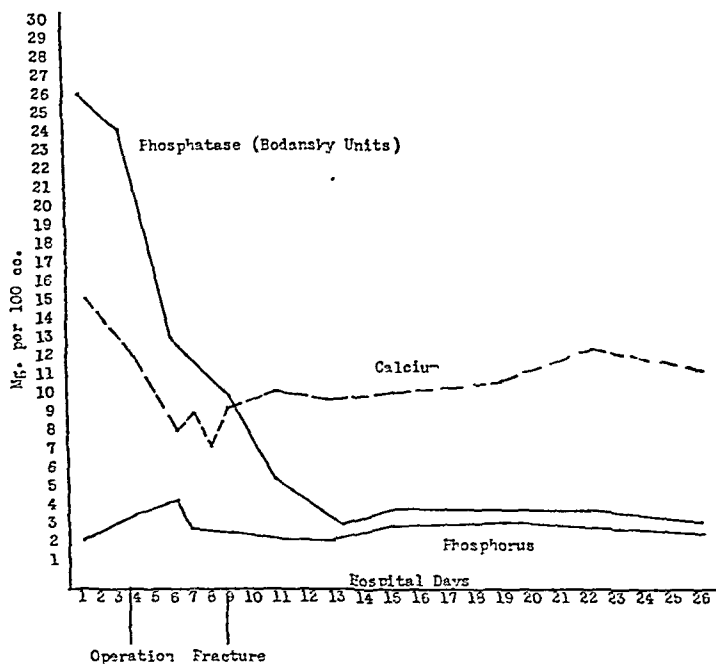


FIG. 4. Laboratory data in case.

as a result had gained approximately twelve pounds.

Approximately six months following her operation she returned for removal of her cast at which time the fracture of the femur was well united. (Fig. 1H.) X-ray examination showed continued recalcification of the entire skeleton. Many of the cystic areas in the ex-

tremities had completely changed. She was walking quite well with the aid of crutches. She still had a marked dorsal kyphosis. Her blood calcium was 11.8 mg., blood phosphorus 3.6 mg. and blood phosphatase 1.7 Bodansky units. Films of the abdomen taken at this time still showed the areas of nephrocalcinosis in both kidney regions to be essentially the same as on previous

examinations. This fact led us to give a guarded prognosis as it has been shown that these deposits may ultimately result in the death of the patient through the continued destruction of kidney tissue long after the primary tumor has been removed.

#### SUMMARY

A severe case of generalized osteitis fibrosa cystica due to parathyroid adenoma is reported, the tumor being located in the superior mediastinum. The case is remarkable in that the patient's symptoms date back over a period of nearly sixteen years during which time she suffered no less than four fractures and one operation for kidney stones. The skeletal involvement was extensive and included both patellas, a site which has not been previously reported. Her postoperative convalescence was marked by a fracture of the right femur, suggesting that in the postoperative

care of these patients precautionary splinting might be applied to bones of the extremities which are extensively involved until some degree of recalcification has occurred.

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# PENETRATING WOUND OF THE ABDOMEN TREATED WITH PENICILLIN

## CASE REPORT

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A CASE of penetrating abdominal wound caused by a hand grenade is reported because of the increasing frequency of this type of abdominal wound in war time and to stimulate further use of penicillin as a chemotherapeutic agent in these cases. This particular case illustrates the severe type of penetrating wound of the abdomen that is common in modern warfare.

### CASE REPORT

A white soldier, aged thirty-one, was disarming a dud hand grenade when the grenade exploded and he was struck by a fragment of metal in the right lower quadrant. He was rushed to the Station Hospital by ambulance and arrived within twenty-five to thirty-five minutes from the time of the injury. He was admitted directly to the operating room and on admission was in shock, with cold clammy skin, rapid thready pulse, blood pressure of 86/48 and a rigid, tender abdomen. A two inch wound was present in the right lower quadrant of the abdominal wall. The patient was given  $\frac{1}{2}$  gr. of morphine sulfate by hypodermic and liquid plasma intravenously. While the plasma was being administered a sample of blood was taken and cross-matched with a donor. A flat plate of the abdomen was made with the portable x-ray while waiting for the operating room to be set up.

Exploratory laparotomy under open and closed ether was carried out immediately without waiting for the condition of the patient to improve. At operation the peritoneal cavity was filled with a large amount of blood and fecal matter. Further examination revealed the proximal end of the cecum and ileocecal junction to be torn into shreds, three large lacerations present in the mesentery of the small bowel, a two inch laceration in the descending colon and a laceration of the retroperitoneal

tissue just above the promontory of the sacrum and in the angle of bifurcation of the great vessels. The bleeding vessels in the torn mesentery were ligated; the tear in the descending colon closed; the proximal one-fourth of the cecum resected and the blind end closed with two rows of chromic No. 00 and a final row of serosa-to-serosa sutures of interrupted black silk. The distal two feet of the ileum was resected and the ileum anastomosed by the open method to the transverse colon in an end-to-side manner, and the tear in the retroperitoneal tissues sutured. The piece of metal was buried in the retroperitoneal tissues and no attempt was made to remove it. Ten Gm. of crystalline sulfanilamide was sprinkled in the peritoneal cavity and using the right lower abdominal wound as a stab wound two soft rubber drains were inserted down to the retroperitoneal laceration and along the right gutter in order to drain the contaminated retroperitoneal tissue. The abdomen was not lavaged but was sponged clean of blood and feces.

During the operation and immediately following the patient received 2,500 cc. of liquid plasma and 500 cc. of whole blood. An additional 500 cc. of whole blood was given when the patient was carried to the ward. During the seven-day period following surgery he received an additional 2,000 cc. of whole citrated blood. A Miller-Abbott tube was inserted into the duodenum before the patient left the operating room and Wangensteen's decompression applied as soon as the patient was sent to the ward and continued for seven days. The patient was given 4,000 cc. of 5 per cent glucose in saline by vein daily following surgery for a total of six days. On the first and second postoperative days he was given 5 Gm. of sodium sulfadiazine intravenously. On the second postoperative day the patient's condition was steadily becoming worse with marked restlessness, toxic appearance, temper-



ature of 102°F., a bounding pulse of 150 per minute and respiration of 24. The abdomen was soft and not distended.

Smears and cultures were taken from the wound in the right lower abdominal wall and penicillin was started with doses of 30,000 Oxford units intramuscularly every three hours. Sodium sulfadiazine was discontinued. On the following day at 8 A.M., after seven doses of penicillin had been given, the patient appeared somewhat less toxic with temperature 101°F., bounding pulse 130 per minute and respiration 22. On the fourth postoperative day the patient began to appear more alert, the pulse rate slowed to 110 per minute and became of better quality and the abdomen remained soft. On the fifth postoperative day the rate and quality of the pulse continued to improve although the abdomen became slightly distended. Some peristalsis was present at this time. On the same day he began to pass flatus and the temperature was 101.5°F. and the pulse 110 per minute. On the sixth postoperative day the temperature was 100°F. and pulse 96 per minute. On the ninth postoperative day the patient had a liquid stool. The patient continued to improve and the penicillin was discontinued on the tenth postoperative day. On the eleventh postoperative day he developed a right-sided pleurisy and a friction rub was noted two days later. Following the onset of the pleurisy, he was given a total of 41 Gm. of sulfadiazine orally over a period of five days, at the end of which time the pleurisy cleared up and the patient improved rapidly except for frequent small liquid stools. He was transferred to a General Hospital for further convalescence on January 11, 1944, ambulatory and in excellent condition.

Smears from the draining wound on the date of the beginning of penicillin therapy, December 1, 1943, revealed numerous bacteria; gram-positive rods and cocci and some gram-negative rods. Some of the purulent material was streaked on blood agar and eosin methylene blue plates and inoculated into thioglycollate broth and cooked meat media. On December 2, 1943, the inoculated thioglycollate broth and cooked meat media were plated out anaerobically and no clostridia were found. Six strains of bacteria were isolated aerobically, namely, (1) *Escherichia coli* communis; (2) gram-negative, non-motile short rods of undetermined species; (3) *Staphylococcus albus*, non-hemolytic; (4) *Staphy-*

*lococcus albus*, hemolytic; (5) alpha hemolytic streptococcus, and (6) gram-positive aerobic spore-forming rod, culturally and morphologically resembling *Bacillus subtilis*.

A smear from the draining wound taken on December 6, 1943, the sixth day of penicillin therapy, revealed very few bacteria, namely, gram-positive cocci and gram-negative rods. Some of the drain material was again streaked on blood agar and eosin methylene blue plates and inoculated into thioglycollate broth. On December 7, 1943, no clostridia were found in the thioglycollate broth and only three strains were isolated aerobically: (1) *Escherichia coli* communis; (2) gram-negative, non-motile short rods of undetermined species, and (3) *Staphylococcus albus*, non-hemolytic.

The day following the operation the red blood cell count was 3,310,000 and the white blood cell count was 12,700 with 83 per cent polymorphonuclears and on December 3, 1943, the red blood count was 2,100,000 and hemoglobin 30 per cent by the photo-electric method. Following this the red cell count rose steadily to 4,490,000 with 95 per cent hemoglobin by the photo-electric method on December 16, 1943. The blood chloride was 322 on December 2, 1943, 218 on December 3, 1943, increased to 459 on December 4, 1943, and remained normal thereafter.

#### COMMENTS

This type of penetrating abdominal injury is typical of the abdominal wounds encountered in war with extensive damage due to large and irregularly shaped metal fragments. Penetrating abdominal wounds seen in civilian life are usually due to knife or gunshot. Many of these civilian wounds involve only the small or large bowel separately although Elkin and Ward<sup>1</sup> reported a combination of large and small bowel injuries as being quite frequent in their series of 238 cases. Wounds of the large bowel are frequently associated with wounds of the retroperitoneal tissues and infection of the retroperitoneal tissues according to Heyd<sup>2</sup> and Bailey<sup>3</sup> is severe and rapidly fatal due chiefly to the virulence of the anerobic flora that arises from the colon. Bailey<sup>3</sup> states that the early escape of the fluid fecal matter from the lumen of the large bowel in cases of

gunshot injuries seems more frequent than from the small gut and its occurrence augments the gravity of the prognosis. A peritoneum inundated with a flood of highly infected fluid from the intestines, the extraperitoneal tissues or psoas muscle soaked and sodden with escaping contents render effort to save the patient fruitless and wasteful of time. Marks<sup>4</sup> reports seven abdominal war wounds in which the peritoneal cavity was penetrated with a mortality of 14.3 per cent. Three of these involved multiple perforations of the bowel.

The mortality of penetrating wounds of the abdomen remains high in civilian cases and even more so in war wounds in which there is often extensive damage to multiple viscera and the retroperitoneal tissues with a long interval between the time of injury and the time of surgery. Hamilton and Duncan<sup>5</sup> report an operative mortality of 48.9 per cent in 190 cases of gunshot wound of the abdomen; Elkin and Ward<sup>1</sup> report an operative mortality of 46.4 per cent in a series of 209 rifle and pistol wounds of the abdomen and 55.5 per cent in twenty-nine cases of gunshot wounds of the abdomen; DiLorenzo<sup>6</sup> and co-workers report a mortality of 78 per cent in nine cases of gunshot wound of the small bowel and 71 per cent in seven cases of gunshot wound of the large bowel; Mulholland<sup>7</sup> reports a mortality of 51 per cent in seventy cases of penetrating abdominal wounds.

Hemorrhage and shock are usually severe in the penetrating abdominal wounds of the war type and account for a high percentage of deaths in these cases. Hamilton and Duncan<sup>5</sup> point out the importance of hemorrhage and the tremendous part it plays in the effect on mortality. They report a mortality of 73.4 per cent in cases with hemorrhage over 1,000 cc. as compared to a mortality of 27.8 per cent in those with hemorrhage under 500 cc. The time interval from injury to operation is another important factor and probably played a large part in saving the life of

the patient reported in this article. Age is another important factor in influencing the mortality. Hamilton and Duncan<sup>5</sup> report a considerable increase in mortality in their patients who were over forty years of age.

The diagnosis of penetrating abdominal injury is not difficult as a rule and should be suspected in any case with a wound of the abdomen, buttocks or thigh. According to Griswold<sup>8</sup> the presence of shock out of proportion to the wound is indicative of internal abdominal damage with hemorrhage. The majority of patients with penetrating abdominal injury are in shock with a rigid tender abdomen. All wounds of the thigh and buttocks should be examined carefully in order to determine the presence or absence of intra-abdominal injury. This is particularly true of war wounds. In one of Marks<sup>4</sup> cases of abdominal war wounds a wound of the flank also had a penetration of the kidney and in another case a missile entered the sacrum and involved the bladder and sigmoid.

At times a flat plate of the abdomen is of value in helping one determine pre-operatively the extent of damage. By locating the metal fragment a rough idea of the course of the fragment through the peritoneal cavity may be arrived at. This may be done with a portable machine while the operating room is being prepared with no loss of time and little disturbance to the patient.

The treatment of a penetrating wound of the abdomen is immediate transfusion of whole blood or plasma and early operation. One should not wait for shock to improve and delay operation. Griswold<sup>8</sup> points out that when active intraperitoneal bleeding is going on, it cannot be counteracted by intravenous medication and delay in treatment is fatal. Mulholland<sup>7</sup> reports three cases in his series in which death was due to hemorrhage while attempts were being made to relieve shock. Opinion among writers on the subject concerning anesthesia in this type of case varies with the majority in favor of nitrous

oxide and ether. In Marks<sup>4</sup> series of abdominal war wounds on the Buna front spinal anesthesia was used as ether was impractical since it volatilized slowly or not at all.

The right rectus splitting incision seems to be preferred by most authors on the subject but Bailey<sup>3</sup> favors a midline incision in war wounds because of the ease of closure and good exposure for extensive intra-abdominal injury. After the abdomen is opened all bleeding should be stopped immediately without regard to perforations of the bowel. Following this the gastrointestinal tract should be thoroughly explored and clamps placed on tears in the bowel. An illustration of how easy perforations in the bowel may be missed is demonstrated in a case of gunshot wound of the abdomen caused by a pistol bullet treated by one of us (W. H. K.). Careful examination of the gastrointestinal tract revealed a large perforation in the small bowel which was repaired. No evidence of any other perforation was present although the entire bowel had been thoroughly inspected with the exception of a small portion of the descending colon, and the probable course of the bullet was such as to lead one not to suspect injury in this locality. The abdominal incision was enlarged in order to inspect this one remaining area and a small tear was found on the posterior wall of the descending colon. Hamilton and Duncan,<sup>5</sup> and Rippey<sup>9</sup> point out the increased number of missed perforations in hurried operations which accounts partly for the high mortality in those cases with an operating time of one hour or less.

Most authors including Heyd<sup>2</sup> and Griswold<sup>8</sup> advise closure of multiple perforations rather than resection as the latter carries a higher mortality. Griswold<sup>8</sup> calls attention to the fact that in the presence of two perforations close together closure is sometimes made easier by converting the two openings into one. When resection of the small bowel is necessary primary resection is the method of choice

followed by the use of the Miller-Abbott tube and Wangenstein's decompression. In the present war primary anastomosis of the large bowel is not recommended but rather exteriorization with the formation of a colostomy. In a review of the limited literature available no mention is made of the procedure of choice in the type of bowel injury with destruction of the proximal portion of the cecum and the ileocecal junction. It seems that in such cases resection and closure of the proximal end of the cecum and anastomosis of the distal end of the ileum to the transverse colon is the method of choice. The Miller-Abbott tube provides adequate decompression and prevents tension on the suture line. Whipple<sup>10</sup> recommends anastomosis by the open method in an end-to-side manner of the ileum to the transverse colon in elective cases of carcinoma of the cecum, ascending colon, hepatic flexure and especially in terminal ileitis with resection of the cecum and right colon. In Whipple's<sup>10</sup> experience anastomosis by the open method, with the proximal bowel decompressed, with careful protection of the wound and remaining peritoneum and with accurate suture technic, is as safe as the so-called aseptic methods and more certain of giving an adequate stoma and avoiding subsequent leakage. In extensive war wounds of the abdomen, in which one is dealing with a peritoneum already grossly contaminated with bowel contents, the open type anastomosis carried out with care to prevent further contamination is time-saving and probably the method of choice.

In the presence of tears in the mesentery of the small bowel, especially near the root or the mesenteric border of the bowel, one must be careful to determine the viability of the bowel following closure of these rents. In the case herein reported an attempt was made to close two tears in the mesentery of the small bowel near the root and inspection of the bowel thirty minutes later showed considerable change in the terminal two feet of ileum from a

normal pink to a dusky blue making it necessary to resect this portion of the bowel.

When a resection of the small bowel is necessary Heyd<sup>2</sup> believes there is a 10 per cent greater safety in performing a lateral anastomosis. Saltzstein and Podalsky<sup>11</sup> have shown in their work with dogs that in an end-to-end anastomosis of the bowel there is liable to be necrosis of the distal end, especially on the anti-mesenteric border, but in a lateral anastomosis the blood supply is sufficient.

After the bowel injuries have been cared for the peritoneal cavity should be mopped clean with sponges. Storck,<sup>12</sup> Griswold,<sup>8</sup> Mulholland<sup>7</sup> and Elkin and Ward<sup>1</sup> advise against lavage of the peritoneal cavity as this may cause transmission of infectious material. Most authors are against any attempt to drain the peritoneal cavity unless there has been retroperitoneal injury, damage to the biliary tract, bladder or pancreas. The use of sulfanilamide intraperitoneally in doses of 5 to 10 Gm. is recommended, although Rea<sup>13</sup> states it is clinically impossible to judge its value.

The incidence of evisceration is high in these cases as pointed out by Griswold,<sup>8</sup> and Hamilton and Duncan.<sup>5</sup> The latter two show an incidence of 5.6 per cent evisceration in their series between the sixth to tenth postoperative day. Griswold<sup>8</sup> believes it may be advisable to use through-and-through sutures of non-absorbable material because of the high incidence of postoperative evisceration.

Postoperatively, these patients should have continuous Wangenstein decompression with a Levine tube or preferably a Miller-Abbott tube. Frequent transfusions and adequate fluids parenterally, 3,000 to 4,000 cc. of 5 per cent glucose in saline daily, should be given. The blood chlorides should be checked frequently and maintained at a normal level. Sodium sulfadiazine by vein in doses of 5 Gm. daily is recommended. Penicillin, when available, may prove to be the chemotherapeutic

agent of choice as it is known to be effective against the *Staphylococcus albus* and *aureus*, hemolytic streptococcus, *Clostridium Welchii*, *Clostridium septicum*, *Clostridium histolyticum*, *Bacillus sporogenes*, *Bacillus oedematiens* and *Bacillus sordellii*. Dawson, Hobby, Meyer and Chaffee<sup>14</sup> have shown that penicillin is highly effective against gram-positive organisms, both aerobic and anaerobic and more effective against strains of hemolytic streptococcus than strains of staphylococcus. These workers demonstrated that penicillin is active in extraordinarily high dilutions and it is many thousand times as effective as any of the sulfonamides. They proved that penicillin has a remarkable effect on mice infected intraperitoneally with a highly virulent strain of *Streptococcus hemolyticus* and treated with small amounts of penicillin subcutaneously. This same group of authors showed in further experiments with guinea pigs infected with *Clostridium Welchii* and white mice infected with *Clostridium septicum* that, whereas small amounts of penicillin protect against large numbers of highly virulent hemolytic streptococci, comparable amounts will give partial or complete protection against only two to three lethal doses of *Clostridium Welchii* and *Clostridium septicum*.

Although no anerobic spore-forming organisms were isolated from our case the penicillin was probably effective against the hemolytic staphylococcus and alpha hemolytic streptococcus. Smear and cultures taken on the sixth day of penicillin therapy revealed only a few bacteria present on smears, whereas the first smears showed numerous bacteria. Cultures on the sixth day of penicillin therapy isolated aerobically only *Escherichia coli*, gram-negative non-motile short rods and a strain of non-hemolytic staphylococcus, whereas the original cultures isolated aerobically in addition a strain of hemolytic staphylococcus *albus*, alpha hemolytic streptococcus and an organism resembling *Bacillus subtilis*. Penicillin is excreted

rapidly when given by intravenous and also intramuscular route according to Dawson<sup>14</sup> and co-workers and at the end of two to four hours penicillin can no longer be detected in the circulating blood. When given by intramuscular injection the blood concentration is never as high as after intravenous injection but a higher level is maintained for a longer time. Because of its rapid excretion penicillin is best given every three hours by the intramuscular route in doses of 30,000 Oxford units. No toxic effects were observed in this case.

Although it is difficult to evaluate the part penicillin played in this case it is believed that this chemotherapeutic agent was of definite value as the patient began to show improvement after seven doses of penicillin and improved steadily from that time on as regards his abdominal injury.

#### CONCLUSION

1. A case of penetrating abdominal wound caused by a hand grenade is presented which demonstrates the extensive nature of war wounds.

2. Penicillin is believed to be of definite value in this type of case and with further work may prove to be the chemothera-

peutic agent of choice in penetrating wounds of the abdomen.

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# COMBINED INTERCOLIC AND EXTERNAL FISTULA CAUSED BY CARCINOMA OF THE SIGMOID

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RESERVE

THE incidence of fecal fistula due to malignancy is not high (4.9 per cent of 264 cases of fecal fistula studied by Rankin and Gorder). Combined internal and external fistulas on a malignant basis are very much less frequent than this. For this reason we consider it well to report this interesting case of carcinoma of the sigmoid which produced not only an external fistula but also another between the sigmoid and transverse colon.

## CASE REPORT

W. F., a fifty-four year old white American fireman, entered the Monterey County Hospital on September 25, 1942. Nine months before admission he noticed occasional lower abdominal cramps. Two months later these had become confined to the left lower quadrant and became progressively more persistent and severe. He became increasingly constipated and distended. Laxatives and enemas became more and more ineffectual. Three weeks before entry the pain was constant instead of intermittent, had increased in severity, doubled him up at times. In spite of his difficulties he continued to work until September 16, 1942, when he collapsed while riding on a fire truck. He was taken to a military hospital where emergency surgery was performed, as described by the following letter from that hospital:

"Mr. F. was admitted to this hospital at 9:20 A.M., Sept. 16, 1942, complaining of severe pain in the left groin of 19 hours duration. Temperature 101, pulse 95, and respirations 22. Patient denied any previous similar attacks.

"Examination revealed an adult male in severe pain; physical examination was essentially negative, except for the abdomen which was somewhat distended; tenderness in left lower abdomen, adjacent to the groin. There was a definite mass felt in the left inguinal canal which was felt to be an incarcerated hernia. Patient was operated on immediately

and a left inguinal incision made. A large portion of gangrenous retroperitoneal fat was seen in the region of the internal ring. On exploration by enlarging the incision anteriorly, an abscess was opened containing greenish foul smelling pus. The abscess cavity was found to extend anterior to and laterally along the abdominal wall, lying between the peritoneum and abdominal muscles. The cavity was felt to extend about 10 cm. above the incision. This was packed with vaseline gauze and the lower portion of the incision was closed with drainage at the tip.

"Post-operative course rather uneventful. Temperature 99-100. Daily dressings, with the large gauze pack out on the 7th day. Moderate drainage occurs. Small vaseline pack still present in cavity.

"Patient has had 53 grams of sulfadiazine by mouth, also iron therapy.

"B. coli found in culture from abscess.

"Complete blood count Sept. 23, 1942: R.B.C. 4,150,000, W.B.C. 12,450, Hemoglobin 90, Differential: segmented cells 56, scabs 2, eosinophiles 3, lymphocytes 27; urine showed occasional pus cell."

The patient was then transferred to Monterey County Hospital on September 25, 1942. His father had died in his sleep at seventy-one. His mother died at 50 following several rectal operations which the patient believes were for cancer. He had six brothers: one died at nineteen of ruptured appendix, another was shot, one died of heart trouble, one is suspected of having cancer of the stomach at fifty. His paternal grandmother died of cancer of the breast. He had had the usual childhood diseases and pneumonia at twenty-six. He also suffered with acute frontal sinusitis at forty-two. He had otherwise been quite well before the present illness.

Physical examination revealed a well developed and nourished man in no acute distress. Temperature was 98.6°F.; pulse 80, respirations 20, blood pressure 120/85. The remainder of

examination was negative except for the abdomen. There was a partially healed left inguinal incision with a vaseline gauze drain



FIG. 1. Barium enema before operation. Only a faint trickle of barium can be seen above the upper sigmoid.

and a small amount of thick light brown exudate. There was considerable induration, but very little tenderness about the wound. On gentle probing it was found that the tract led superiorly and laterally into the abdomen. There was no abdominal rigidity and peristalsis was active. Rectal examination was entirely negative. It was believed that he had a fecal fistula due to either a carcinoma or diverticulum of the sigmoid.

Laboratory findings were as follows: Wassermann, Kahn, and Kline negative; hemoglobin 11 Gm., red blood cells 3,700,000, white blood cells 11,700; differential: neutrophils 59, nonfilamented 15, lymphocytes 20, eosinophiles 6. Urine: Specific gravity was 1017, albumen 0, sugar 0, sediment, occasional hyalin cast. The tuberculin test was negative. Culture from fistula showed *Bacillus coli* and *Bacillus alkaligenes*.

The proctoscope was easily passed into the rectum for 20 cm. at which level it was stopped by a firm tender mass. The mucous membrane was normal and the mass seemed to be extrinsic. A barium enema (Fig. 1) revealed almost complete obstruction of the sigmoid

with only a small trickle of barium seeping into the descending colon.

He was placed on a low residue diet, and sulfaguanidine was administered. His bowels moved well and he gained weight. This improvement was undoubtedly due to subsidence of the inflammatory process following drainage of the abscess. The fecal fistula persisted.

When our service began on December 1, 1942, he was on the ward. Because of the long history typical of obstructing carcinoma of the sigmoid, and because of the x-ray findings, we decided upon surgery which was performed on December 12, 1942. Preoperative preparation, in addition to the routine, consisted of a five-day course of suxinil sulfathiazole as well as concentrated doses of vitamins.

The operative procedure was carried out under spinal anesthesia using pontocaine and glucose. A hard mass (Fig. 2) was found in the mid-sigmoid. This was annular and almost occluded the bowel. There was only slight proximal dilatation of the colon. The transverse colon, at its mid-point, was firmly adherent to the sigmoid mass, which seemed to invade it. Firm nodes (later proved to be inflammatory) could be felt in the mesosigmoid. The liver was smooth. There was a fistula from the sigmoid through the left lower abdominal wall. The tissue in this area was quite firm because of the prolonged inflammatory process.

After inserting iodoform gauze into the fecal fistula, an oblique left inguinal incision was made, extending from above the anterior superior spine of the ilium to the pubic spine. An ellipse was made surrounding the fistula, every effort being made to stay away from the infected tract. The edges of the skin ellipse were rolled over the fistulous opening and sutured to each other, thus closing off the external end of the infected sinus. Instruments used up to this point were discarded and the wound edges were re-draped. Medially the incision was carried down through the external oblique, internal oblique, and transversalis fascia. The peritoneum was opened, exposing the descending colon, sigmoid, and the tumor. The fistula was not exposed or disturbed. As soon as the true situation was understood, it was seen that resection would have to extend from the proximal transverse colon to the distal sigmoid. (Fig. 2.)

The peritoneum lateral to the descending colon was divided, the colon displaced medially.

The left colic vessels were doubly clamped and divided. The dissection was carried superiorly, the splenic flexure being mobilized. The transverse mesocolon was then divided to a point well proximal to the intercolic fistula. After determining the adequacy of the blood supply to the proximal segment, the transverse colon was divided by cautery between a Furniss clamp proximally and a crushing clamp distally. The sigmoid distal to the tumor was then mobilized by division of the mesosigmoid, and the bowel divided by cautery between a Furniss (distal) and a crushing clamp.

The resected bowel and tumor were then freed from the posterior and left lateral abdominal walls, the lateral branch of the elliptical skin incision carried down to the abdominal cavity. The resected colon, regional nodes, carcinoma, fistulas, and block of tissue surrounding the external fistula, were removed *en bloc*. It was not necessary to open into the fistula.

The proximal transverse colon and distal sigmoid were then anastomosed end-to-end over the Furniss needles. An inner row of continuous No. 00 chromic was inserted anterior and posterior to the proposed stoma. Interrupted mattress sutures of fine silk (Halsted) were then inserted around the entire anastomosis and the Furniss needles withdrawn. The mesocolon was then sutured with continuous plain catgut so as to prevent herniation of intestine. Sulfanilimide powder was placed over the anastomosis.

Closure was rather difficult because of the extensive bloc of abdominal wall which had been removed. The peritoneum was sutured with continuous fine chromic, the transversalis fascia with continuous No. 1 chromic, and the external oblique with interrupted mattress sutures No. 1 chromic. At the mid-point of the wound a rubber dam drain extended down to the peritoneum. Sulfanilimide powder was sprinkled between the various layers of the wound. Clips were placed in the skin.

A cecostomy was then performed through a right McBurney incision as a safety opening, should distention take place. A mushroom No. 28 rubber tube was inserted into the cecum, two purse string sutures inverting the bowel around it.

The pathological report by Dr. James B. McNaught is as follows: Gross specimen weighs 360 Gm. It consists of a large bowel which

has been opened longitudinally. Ten cm. from one end is an ulcerated rosette of tumor (A) 4.5 cm. in diameter with firm, raised edges

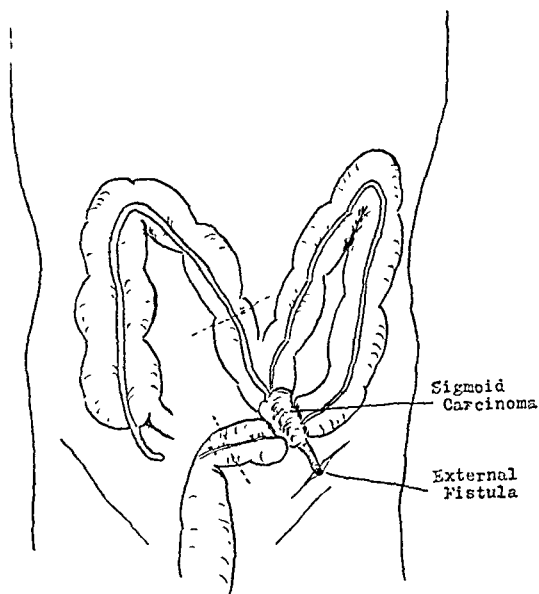


FIG. 2. Diagram of the sigmoid carcinoma adherent to the transverse colon, also the external fecal fistula. Colon was resected at the dotted lines.

and ulcerated center. The tumor extends completely through the wall of the bowel and is adherent to the serosal surface of the adjacent bowel, leaving a large loop of colon free above. The tumor invades the wall of the adjacent loop (B), but it is not exposed on the mucosal surface. There is a sinus tract leading from the crater in the primary tumor, toward this adherent loop of bowel, which also winds its way through a dense mass of tissue leading to the abdominal wall (C). The fatty tissue adjacent to the tumor contains many firm lymph nodes.

Microscopically, sections of (A) show abrupt change from normal glandular mucous membrane to markedly atypical branched glands which extend deep into the wall, penetrating through the muscular layer into the subserosa. The nuclei of these glands are at various levels and show moderate numbers of mitotic figures. The surface is ulcerated. The stroma about the tumor contains large numbers of lymphocytes, eosinophils, and polymorphonuclears. The subserosal tissue shows a marked fibroblastic proliferation with small abscesses and foreign body giant cells. Sections of (B), the loop of bowel which was adherent to the tumor, show



a normal wall except for proliferative fibrous tissue of the subserosa which is of the same inflammatory nature as that described beneath



FIG. 3. Barium enema five months after operation. Notice the absence of the large sigmoid loop and the low position of the new splenic flexure.

the primary tumor. The epithelial tumor has not invaded the wall of this segment of the bowel. Sections of (c), the sinus tract leading from the primary tumor to the abdominal wall show the lining to be a vascular granulation tissue containing myriads of lymphocytes, eosinophils, and polymorphonuclears, and occasional atypical epithelial-lined glands resembling the tumor in the bowel. The outer wall is dense fibrous tissue containing focal collections of leucocytes of various types and many hemosiderin-laden phagocytes. Sections of thirteen lymph nodes found in the region of the primary tumor show no evidence of tumor

metastasis. They show only an inflammatory proliferation of lymphoid tissue. Several of them are surrounded by fibroblastic granulation tissue as described in the bowel. The diagnosis is: carcinoma, colon (adenocarcinoma); peritonitis, subacute, local adhesive fistula, intercolonic; fistula, colon to abdominal wall; lymphadenitis, chronic, regional.

The postoperative course was uneventful except for a transient atelectasis in the right lower lobe on the third day. Postoperative treatment included transfusion, vitamins, sulfathiazole, and sulfasuxidine. A small saline enema brought forth fecal matter on the eighth day, and spontaneous bowel movements occurred each day after the tenth. The cecostomy tube was removed on the thirteenth day. The cecostomy wound healed spontaneously and rapidly. The main operative wound healed by first intention. There was only a small amount of serous drainage. His general condition was excellent at the time of his discharge.

This patient has remained entirely well, working steadily as a foreman in a defense plant. He has had one to two normal bowel movements per day. A barium enema five months after operation (Fig. 3) showed a normal bowel except for the low lying splenic flexure. The site of anastomosis could not be seen.

#### SUMMARY

We have presented a case of carcinoma of the sigmoid with an intercolic fistula to the transverse colon, and an external fistula with abscess formation. Resection of the transverse colon, splenic flexure, descending colon, and sigmoid was carried out. A primary anastomosis was made between the proximal transverse colon and distal sigmoid. No metastases were found and recovery was uneventful.



# PAINFUL SHOULDER DUE TO LESIONS OF THE CERVICAL SPINE

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IT is generally assumed that a painful shoulder has its origin in local conditions. This conception has been strengthened by the contributions of Codman<sup>1</sup> and others<sup>2,3</sup> who demonstrated pathological changes in the periarticular structures of the shoulder joint. Consequently, one is often inclined to overlook the possibility of referred pain from other regions.

The diagnostic problems involved in ascertaining the basis for pain in the shoulder region, with or without radiation into the corresponding extremity, may be very perplexing. This paper proposes to deal only with certain lesions of the cervical spine which may cause a painful shoulder associated with radiation into the arm.

## ILLUSTRATIVE CASES

### *Hypertrophic Arthritis of the Cervical Spine.*

The patient, a white male, age sixty-five, was first seen on February 7, 1942. He complained of severe pain in the right shoulder region and arm, the onset of which was one week previously. There was no history of trauma. The onset was gradual. The pain fanned out over the shoulder region, radiating down the mesial aspect of the arm, and then continued into the radial aspect of the forearm as far as the dorsum of the wrist. He described the pain as "sickening in nature." The pain was present especially whenever he stood up. He learned that he could relieve it by propping himself up in bed with the head in a position of flexion. He could elicit the pain by attempting to hold his head erect; it would first reappear in the shoulder region and then radiate into the aforementioned pathway. He described the radiation of the pain as though "someone were pouring molten lead down his arm."

His general health was good. Further questioning revealed that he had experienced a dull ache in the cervical spine on occasion for the

past several years. The ache was transitory and had not been of sufficient intensity to incapacitate him. He also had had low back pain in the past.

Physical examination revealed no abnormalities of the right shoulder joint or arm. There were no reflex or sensory changes. The neck was held rigidly. Tenderness of the cervical spine was noted, particularly on the right. Marked limitation of hyperextension was present. Flexion was not limited or painful. Any attempt to hyperextend the spine or to flex it to the right immediately elicited the pain of which he complained.

Laboratory examination did not reveal any abnormalities in the blood count, blood chemistry or sedimentation rate. A complete x-ray study of the cervical spine was made. Lipping of the inferior margin of the fifth, both margins of the sixth, and the superior margin of the seventh vertebrae was evidenced. (Fig. 1.) The adjacent posterolateral margins of the vertebrae, where they form the anterior borders of the intervertebral foramen, presented hypertrophic changes which were progressively more marked from above downward, with the exception of the last cervical intervertebral foramen which showed very little abnormality. The osseous changes were responsible for a definite narrowing of the intervertebral foramen. This finding was much more marked on the right than on the left. (Fig. 2.) X-ray examination of the shoulder joint was negative.

Head traction with the cervical spine in a position of slight flexion was administered with prompt subsidence of symptoms. He was able to go without sedation for the first time since the onset of the pain. Motion of the spine increased slowly. Continuous traction was maintained for twelve days, following which he was permitted to be without the suspension for gradually increasing periods of time. He was advised to use neck traction whenever pain in the cervical spine or shoulder region was noted. He has had no severe recurrent attacks.

*Comment.* This patient had been under treatment for a "painful shoulder" for one week prior to the date of examination



FIG. 1. Lateral roentgenographic view of cervical spine, showing lipping of the fifth, sixth and seventh bodies.

by the writer. The clue to the diagnosis was made by examination of the cervical spine. The exact symptoms could be elicited by attempting to hyperextend or to flex the spine to the right. The referred pain promptly subsided when the spine was flexed.

It is generally accepted that hypertrophic arthritis of the spine may be associated with radicular symptoms. This syndrome was pointed out by von Bechterew<sup>4</sup> in 1893. Many cases of hypertrophic arthritis of the cervical spine are associated with referred pain into the shoulder region, arm or forearm. Sensory changes may also be an accompaniment. On occasion, atrophy or even some disturbance of muscle function may be present.<sup>5</sup> Nachlas<sup>6</sup> has recorded cases of pseudo-angina pectoris originating from

hypertrophic arthritis of the cervical spine. Hanflig<sup>7</sup> has confirmed this finding.

Hypertrophic arthritis of the intervertebral articulations and/or thinning of the disk which results in narrowing of the intervertebral foramen, is the basis of the root pain. Whether or not there is actual compression of the nerve root or inflammation of the supporting tissues of the root is a moot question. Semmes and Murphey,<sup>8</sup> on the other hand, believe that this condition seldom causes root pressure. Although they do not flatly deny the existence of this syndrome, they claim that the great majority of cases are due to rupture of an intervertebral disk.

The outstanding characteristic of this syndrome is the elicitation or aggravation of the root symptoms on hyperextension of the cervical spine. Flexion, on the other hand, usually causes the pain to abate or disappear completely, as was demonstrated in the case presented. The pain is promptly relieved by traction on the neck with the head in a slightly flexed position. Overhead traction can either be used at a hospital or set up at home. Hanflig<sup>9</sup> has devised a simple, inexpensive apparatus for home use. Following relief by traction, a cervical collar or brace may be used depending upon the indications in the individual case. Deep x-ray therapy has been tried and found to be of value in these cases.<sup>10</sup>

*Carcinoma Metastasis to the Cervical Spine.* The patient, a white female, age forty-seven, was first seen on January 13, 1942. She complained chiefly of pain in the left shoulder region extending into the mid-arm. There was no history of trauma. The onset was gradual. Five months prior to examination she began to have aching of the left shoulder region. The pain gradually increased in intensity and began to radiate into the arm. During this period she also noted intermittent aching of the neck. In January, aching of the right shoulder region on occasion was present for the first time. She had lost ten pounds since the onset.

After the x-ray examination additional history was obtained from the patient's husband.

In October, 1939, she had a resection of the colon for adenocarcinoma. There were no symptoms referable to the gastrointestinal

including the pelvis was then made. Slight hypertrophic arthritic changes were found, but there was no evidence of metastatic involve-



FIG. 2. Right and left anterior oblique roentgenograms of cervical spine. Note narrowing of fifth intervertebral foramen on right as compared with left.

tract since operation. The patient herself was unaware that she had had a malignancy.

Physical examination revealed no abnormalities of the shoulder joints. No sensory changes were found. The left biceps jerk was absent. The cervical spine was tender to palpation on the left. No tenderness of the right side of the neck was elicited. Motion of the cervical spine was limited in all directions, associated with pain on the left. The muscle examination of the upper extremities did not show any weakness. Abdominal palpation failed to reveal the presence of tenderness or masses.

A complete blood count was essentially negative. The sedimentation rate, however, was somewhat increased. Roentgenographic examination of the cervical spine revealed definite narrowing of the fourth vertebral body. (Fig. 3.) The lung film was essentially within normal limits. A complete spine study

ment. A presumptive diagnosis of isolated carcinoma metastasis to the cervical spine was made.

The patient was hospitalized and neck traction was applied. The pain, however, did not abate. On July 20th, definite weakness of both arms was noted. The biceps reflex was absent bilaterally. Because of the persistent, increasing pain, deep x-ray therapy was tried. She continued to lose ground. Prior to her death in December, 1942, she developed numerous manifest metastatic osseous foci, including pathologic fractures of the right clavicle and humerus.

*Comment.* This patient had been treated for "neuritis" for several months. During this period she had been given the complete armamentarium of drug therapy without relief of the symptoms. The clues in this instance that one was dealing

with a lesion of the cervical spine were the lack of physical findings in the shoulder joint and the positive signs in the neck.



FIG. 3. Lateral roentgenogram of cervical spine showing collapse of fourth vertebral body due to carcinoma metastasis.

An isolated, far-advanced metastasis to the cervical spine from an original focus in the colon is unusual. The presumptive diagnosis of a metastatic lesion was confirmed by the subsequent clinical course. The referred pain was probably due to compression of the nerve root by tumor tissue. Collapse of the vertebral body might have been a factor, however.

*Tuberculosis of the Cervical Spine.* The patient, a white male, age fifty-six, had been hospitalized for two years at complete bed rest for severe, bilateral pulmonary tuberculosis prior to complaining of a painful left shoulder in 1938. The onset of the pain was gradual and intermittent. Examination of the shoulder joint at this time was essentially negative. Roentgenographic study did not reveal any osseous changes. Local physiotherapy was administered.

The pain increased slowly in intensity, and radiation was then noted in the arm and forearm. He also began to complain of weakness of the arm and inability to raise it. There were no complaints referable to the cervical spine. Examination several months after the onset

revealed no local tenderness of the shoulder joint, slight atrophy of the musculature as compared with the right, limitation of active



FIG. 4. Lateral roentgenogram of cervical spine showing destruction of sixth and seventh vertebral bodies caused by tuberculosis.

abduction to sixty degrees, and a diminution of the reflexes.

The cervical spine was investigated at this time. Marked limitation of motion in all directions was noted, associated with definite tenderness on palpation. Roentgenographic examination evinced widespread tuberculous involvement of the sixth and seventh bodies with wedging. (Fig. 4.)

The cervical spine was immobilized in a plaster cast. Within a period of a few weeks the shoulder pain entirely subsided, and function of the arm returned to normal.

*Comment.* Referred pain in bone and joint tuberculosis is a very common symptom. The complaints referable to the shoulder, especially in the absence of definite physical findings, should have made the examiner suspicious of a cervical spine lesion. It was not, however, until several months later, when signs of root involvement became evident, that the cause of the symptomatology was unfolded. In spite of the advanced changes noted on the roentgenogram, the patient

had not complained of his neck during this period.

The *modus operandi* of the referred pain in this case is compression of the nerve roots by tuberculous granulation tissue. The referred pain, as a rule, responds promptly to immobilization.

*Herniated Cervical Intervertebral Disk.* The patient, a white male, age thirty-one, was first seen on July 1, 1939. Three weeks previously he began to have pain in the interscapular region on the right. There was no history of trauma. The pain was intermittent in character and varied from sharp to dull. On June 26th, he noted pain in the right shoulder region, and it was this symptom which compelled him to seek medical aid. The character of the pain was dull; it was not aggravated by motion except on extremes of internal rotation. Aching of the right elbow region was also present. He also had a tingling sensation of the fingers of the right hand, especially the palmar aspects of the fourth and fifth fingers, for one week. The past medical history was irrelevant.

The physical examination was essentially negative. Questionable tenderness of the anterior aspect of the right shoulder joint was noted. There was no limitation of motion of any joint. The neurological and laboratory examinations were entirely negative. He was treated symptomatically with gradual abatement of the complaints.

He reported for examination again on December 14, 1940, complaining of pain in the right shoulder region which radiated down the arm. He had been pain-free until two weeks prior to this date. The onset was gradual. He again had pain in the right interscapular region, but the main symptoms were situated in the right shoulder region and arm. The pain radiated along the mesial aspect of the arm and forearm, extending as far as the ulnar side of the fourth finger. During this period he noted that his head gradually inclined to the right; any attempt to straighten it gave rise to increased pain in the shoulder and arm.

Physical examination on this occasion showed a high thoracic scoliosis to the left, associated with an inclination of the head to the right. The left shoulder was definitely higher than the right. There were no areas of tenderness of the thoracic spine nor of the interscapular region. The right shoulder joint

was negative. Spasm of the right trapezius was present. The neurological examination did not reveal any sensory or reflex changes. The laboratory examination was negative. A roentgenographic study of the cervicothoracic spine and right shoulder joint showed no abnormalities.

He was admitted to the hospital where he was studied in association with a neurologist. Two spine fluid determinations three days apart showed a positive globulin test, 2 lymphocytes, and 130 and 170 mg. of protein, respectively. Lipiodol studies by the neurosurgeon showed a persistent block at the level of the seventh cervical vertebra.

On January 2, 1941, a laminectomy was performed by Dr. Ralph Stuck. A herniated intervertebral disk between the sixth and seventh cervical vertebrae was found on the right. The postoperative convalescence was uneventful. The scoliosis and pain in the right shoulder and arm had entirely subsided by the time the patient was discharged from the hospital.

*Comment.* The syndrome of rupture of a cervical intervertebral disk is now definitely recognized. Semmes and Murphy<sup>8</sup> believe that this syndrome may simulate "coronary occlusion, angina pectoris, hypertrophic arthritis of the cervical spine, neuritis of the brachial plexus, bursitis, scalenus anticus syndrome or cervical rib."

The symptoms which the patient presented at the first examination did not point to a lesion of the cervical spine. Even at the examination eighteen months later he did not complain of any pain in the cervical spine. He did have pain, however, on both occasions in the right interscapular region. Semmes and Murphy<sup>8</sup> report that pain referred to a point just medial to the upper angle of the scapula, as noted in the case presented, was a constant finding in their series.

The most common symptoms in this syndrome are (1) pain which may or may not be situated in the cervical spine with radiation to the shoulder, arm, scapula or precordium; (2) positive cough and sneeze sign, and (3) spasm of the neck

muscles. Associated sensory and reflex changes may be present. Surgical removal of the herniation gives immediate relief.

#### COMMENTS AND SUMMARY

When a patient presents himself for the relief of pain in the shoulder region and arm, a large variety of conditions must be considered: Among the more important are hypertrophic arthritis of the cervical spine, herniated intervertebral disk, cervical rib, the various neuritides and local lesions of the shoulder region including arthritis, peri arthritis, bursitis, and tears of supraspinatus tendon. This difficult diagnostic problem can be solved only after careful and detailed physical and roentgenographic examination.

The cases reported adequately illustrate the difficulties involved in arriving at a correct diagnosis. Tenderness or limitation of motion of the cervical spine, when present should induce one to investigate further whether this region may account for the symptomatology. Certainly, the cervical spine should be examined routinely in all cases of painful shoulder in which there are insufficient signs to verify the diagnosis of a local lesion or neuritis. The absence of restriction of motion and the absence of a definite point of local

tenderness rules out a lesion of the shoulder joint as the cause of the pain.

It might be stated that a good working rule to follow, also, is that the cervical spine should be scrutinized in those cases of presumptive shoulder pain which do not respond to therapy within a reasonable period of time.

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# COMPRESSION INJURIES OF THE CHEST IN CHILDHOOD

## REPORT OF A CASE COMPLICATING RUPTURE OF THE SPLEEN

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THE War with its attendant casualties in the civil population as well as in the Armed Forces has served to call attention to crushing injuries of the thorax. This attention has, naturally, been focused on the injuries of adults and it is seldom realized that similar trauma in children may produce entirely different injuries. The ribs and cartilages of a child are much less rigid than those of an adult and hence the thoracic cage of a child has a resiliency which allows it to spring back intact after a degree of compression that will produce multiple rib fractures in an adult. It is, therefore, possible for a child to suffer serious damage to the thoracic contents with little or no damage to the chest wall. Usually, however, signs are present which arouse suspicion of an intrathoracic lesion soon after the trauma has been sustained.

A case in point is that of an eight-year old boy admitted to the Children's Surgical Service of Bellevue Hospital after having been knocked down by a truck. He was suffering from shock, a fracture of the pubic bone and a fracture through the lower femoral epiphysis. There was a history of unconsciousness but none of chest injury. It was quickly noted that his sclera were suffused with blood and that there was a dusky, cyanotic color of face and neck stopping abruptly at about the level of the first rib. This is so-called traumatic asphyxia and caused by a compression injury to the chest producing dilation and engorgement of the venous capillaries of head and neck as a result of sudden back pressure in the superior vena cava. There was no demonstrable injury to the thoracic wall in this case and fortunately no other injury to the thoracic contents but the

traumatic asphyxia immediately directed attention to the thorax. It cleared up spontaneously without treatment.

More severe and more dramatic is the case of a seven-year old boy who was riding in the rear seat of an automobile which was abruptly stopped by collision with another vehicle. He was thrown forward and struck the right side of his chest against the back of the front seat. He immediately experienced pain in his chest and some difficulty in breathing. When admitted to the hospital a few minutes later subcutaneous emphysema appeared on the right side of the chest and rapidly spread to the left side, the neck and the abdomen. X-ray showed a little fluid and air in the right pleural space but no injury to the bony thorax nor could subsequent x-rays from any angle demonstrate such injury. With no treatment other than bed rest the subcutaneous emphysema disappeared, the fluid and air absorbed from the pleural space and the lung re-expanded. He was discharged cured. Obviously there had been a tear of the lung producing tension pneumothorax which closed the tear. The tension pneumothorax was relieved by the discharge of air into the subcutaneous tissues, undoubtedly through a tear in the parietal pleura. In this instance there was no other evidence of damage to the chest wall but there was never any doubt as to an injury to the lung.

These two cases are mentioned briefly to illustrate that although the chest wall was intact the intrathoracic damage was apparent. They are in contrast to the following case, also with intact chest wall, in which the pulmonary damage was not apparent to clinical examination even though it later proved fatal, and was not



detected until its effects had become overwhelming.

#### CASE REPORT

The patient was a boy of eight who was admitted to the Children's Surgical Service,

on the left side of the face. There was no bleeding from the ears or nose. Pupils reacted to light and accommodation and there was neither strabismus, nystagmus nor other evidence of intracranial nor cranial nerve injury. The thorax showed neither contusions, lacerations nor abrasions but there was moderate

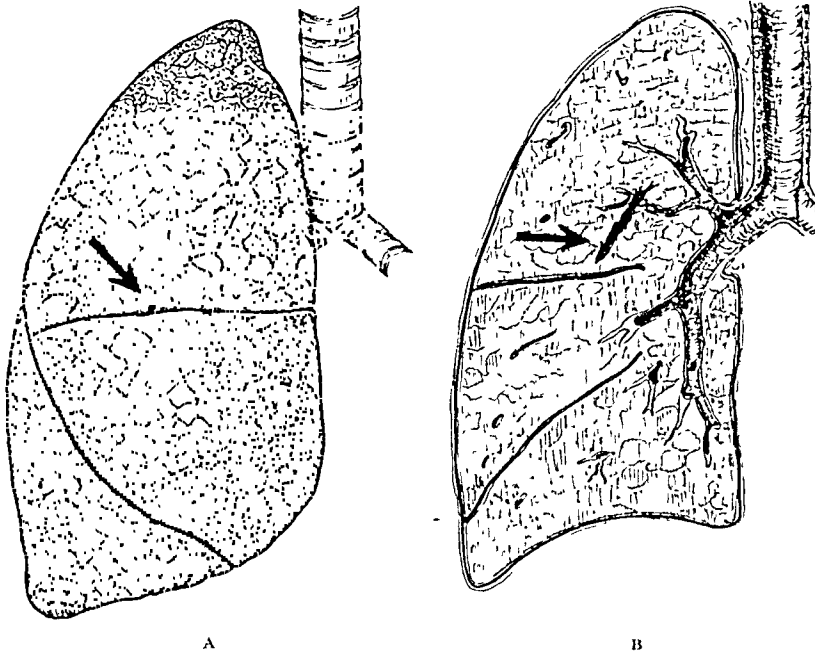


FIG. 1. Sketch of a lung with lesion indicated. A, the pleural surface with arrow indicating the tiny point at which the laceration penetrated the pleura. B, section of lung showing location of laceration within the lung parenchyma. (The original specimen was so thoroughly sectioned that it could not be sketched.)

Bellevue Hospital, about half an hour after having been knocked down by a truck. It was not possible to ascertain the mechanism of the injury other than that he was struck in the abdomen and probably run over. He was unconscious for a few minutes and on regaining consciousness he vomited some food he had recently eaten mixed with dark brown material resembling coffee grounds. On admission he complained of pain in the left side of the abdomen, pain in the pelvis and pain in the region of the left hip.

Physical examination showed a well nourished and well developed boy of eight moving about restlessly on the stretcher. He was somewhat disoriented, very pale and breathing rapidly. Temperature, 99.4°F.; pulse, 144; respirations, 48; blood pressure 120/54. There was a laceration above the right eye and multiple contusions and abrasions were present

tenderness over the left lower ribs. Resonance was normal throughout and on auscultation no râles nor other abnormal sounds were heard, observations corroborated by another examiner. The abdomen was rigid throughout and showed diffuse tenderness which was maximum in the left upper quadrant. Rebound tenderness was present. There was no distention but the presence or absence of masses could not be determined because of rigidity.

In the regions of both hips there were contusions and abrasions. There was slight ecchymosis and swelling over the left pubic bone. Direct and indirect tenderness could be elicited in this region and on motion of the left leg crepitus and false point of motion could be demonstrated over the pubis. The extremities were otherwise not unusual.

Hematocrit was 36; hemoglobin, 10 Gm.; and urine was normal. It was obvious that he

was suffering from a hemorrhage into the peritoneal cavity and the spleen was suspected because of the left upper quadrant tenderness. Fracture of the pubic bone was patent so he was not disturbed for x-rays. Infusion of 5 per cent glucose in normal saline was commenced at once while his blood was being

wound was then enlarged by making a transverse incision at right angles to the longitudinal incision and with this increased exposure the spleen was separated from the diaphragm by sharp dissection, the vasa brevia divided between clamps and the pedicle transfixed and ligated and the spleen removed. The

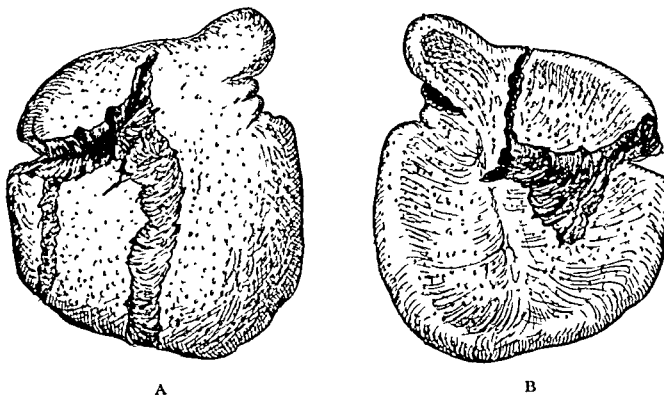


FIG. 2. Ruptured spleen; sketch of specimen from this case: A, convex surface; B, concave surface.

typed and transfusion was substituted as soon as the proper blood could be obtained from the blood bank.

After he had received about 500 cc. of blood his condition improved, his pulse slowed and it was decided to explore his abdomen with the diagnosis of ruptured spleen although his respirations were still rapid. The experience of Cournand<sup>1,2</sup> and his associates in their study of shock and hemorrhage indicate that in hemorrhage a transfusion will bring about a temporary improvement which will permit operation but the operation must not be delayed or the improvement will be lost with the continuing hemorrhage. We believed that he had obtained the maximum improvement and he was, therefore, taken to the operating room with the transfusion still running.

Anesthesia was induced by ether but difficulty was experienced in obtaining satisfactory relaxation. After a delay because of this the abdomen was opened through a long upper midline incision. The peritoneal cavity was found to be full of clotted and fluid blood which was estimated to be about a liter in amount. This was removed by aspiration, sponging and the manual removal of the clots. The bleeding was found to come from an extensively lacerated spleen but because of dense adhesions to the diaphragm the spleen could not be delivered into the wound. The

abdominal wound was closed in layers without drainage.

Meanwhile the anesthetist was experiencing great difficulty. The patient's color was always dusky and there seemed to be obstruction in the air passages. It finally became necessary to pass an endotracheal tube and then aspiration from the trachea produced considerable frank blood. It was at first suspected that in dissecting the spleen from the diaphragm the lung had been injured but an intact diaphragm disproved this.

At the close of the operation respirations were so labored that it was necessary to leave the tube in place for the administration of oxygen and for the aspiration of blood which continued to collect in the respiratory passages rapidly. The respiratory difficulties were ascribed to the pulmonary bleeding at first, but soon it became apparent that there were other factors and it was then recognized that there was a tension pneumothorax on the right. A needle was inserted into the chest and a large amount of air removed but in spite of this cyanosis continued to develop and the patient died about five hours after operation.

Autopsy was performed by Dr. Benjamin Morgan Vance, the relevant features of which follow:

The body is that of a male white child about eight years of age, 4 feet 4½ inches in

height, weighing fifty-six pounds. He is well nourished and well developed. There is an operative incision on the abdomen in the mid-line starting just above the navel and extending upward for a distance of 5 inches. It is joined in the middle by a transverse incision extending to the left at an angle of 90 degrees for  $2\frac{1}{2}$  inches.

There is a laceration behind the outer corner of the right eye and abrasions and ecchymosis are found on the left cheek, over the right greater trochanter and just below the left anterior superior spine.

On section of the abdomen there is about 50 cc. of blood stained fluid in the abdominal cavity. The intestines are moderately distended with gas. There is a stump on the left side with suture marks corresponding to site of the removed spleen. An accessory spleen  $\frac{1}{2}$  inch in diameter is present. The diaphragm on the right side bulges downward. There is air present in the right chest.

The ribs are intact on both right and left sides.

The right lung is compressed and partially collapsed. It weighs 250 Gm. In the upper lobe of the right lung is a subpleural finger-like laceration which extends into the depths of the lung tissue communicating with the bronchi. (Fig. 1.) This extends to the pleura at the interlobar fissure between the upper and middle lobes and measures  $1\frac{1}{4}$  by  $\frac{3}{8}$  by  $\frac{3}{8}$  inches.

The left lung weighs 350 Gm. It contains inhaled blood, almost solid edematous fluid and only a few areas of aerated lung tissue.

The heart weighs 150 Gm. and is contracted and rather pale. The valves, aorta and coronaries are natural. It contains fluid blood and current jelly clot.

The liver weighs 750 Gm. is natural and of dark reddish-brown color. It contains only a small amount of fluid blood.

Gallbladder, kidneys and bladder are natural.

In the pelvis there is a transverse fracture through the inferior ramus of the pubic bone on the left and an oblique fracture through the superior ramus of the same bone. The sacroiliac joint on the left side is somewhat loosened and there is a perivesical hematoma in the region of the pelvic fractures.

The head and brain were not abnormal.

The spleen was brought from the operating room in Bouin's fluid. It weighs 80 Gm. and

has a peculiar shape. One end shows a broad base and the other comes to a teat-like projection. There is a laceration on one side near one pole. At two different points at this location subcapsular lacerations about  $2\frac{1}{2}$  inches long and  $\frac{1}{2}$  inch broad extend down to the convex surface. The laceration forms the letter M. On the hilar surfaces are two small capsular lacerations about  $\frac{3}{4}$  inch long and near the teat-like projection of one pole. (Fig. 2.)

Anatomic diagnoses: Subpleural laceration of the upper lobe of the right lung, hemorrhage into the left lung, pneumothorax, right, laceration of spleen, fracture of pelvis, hemorrhage, contracted heart, lack of blood in circulation.

Cause of death: Laceration of lung and spleen, hemorrhage and pneumothorax, fracture of pelvis.

#### COMMENT

This case presents many points of interest. The patient was a boy who suffered a severe crushing injury which fractured his pelvis and produced a massive intra-abdominal hemorrhage from a ruptured spleen. These conditions were readily recognized. But he also had a laceration of the lung which was not recognized and which is of major importance in this discussion.

At autopsy, except for the partial collapse of the right lung, the chest and its contents appeared normal on first inspection. On closer examination and after section of the lung a laceration was found in the right lung which produced sufficient hemorrhage to fill the left lung. The laceration was entirely subpleural, however, except for a tiny opening in the interlobar fissure. This opening was not sufficient to produce a clinically recognizable pneumothorax until a positive pressure anesthesia was administered; nor was the laceration enough to produce clinically recognizable bleeding until several hours had elapsed. Then the child died of anoxia due to collapse of the right lung from pneumothorax and the drowning of the left lung with blood from the laceration in the right lung.

Undoubtedly, the anesthesia was an important factor in the outcome but

abdominal section was necessary to prevent death from hemorrhage and this could not have been done without anesthesia. Dr. E. A. Rovenstine, Director of the Department of Anesthesia at Bellevue Hospital, believes that inhalation anesthesia using an intratracheal tube was the anesthesia of choice because it allowed a certain amount of fluid to be sucked from the lungs and permitted the delivery of oxygen under pressure. Means should have been taken to relieve the tension pneumothorax before operation, however. This might have been accomplished by inserting a needle into the pleural space and leaving it there during the anesthesia but if this proved inadequate a catheter could have been inserted instead of a needle. In either case this outlet should have been connected to a closed drainage system.

In order to take these measures, however, it is first necessary to make a diagnosis. Chest injuries in children may produce a minimum of signs as this case illustrates. For that reason intrathoracic injury should always be suspected when there has been

a crushing injury in a child and x-ray films of the chest should be made in all cases. In addition, frequent clinical examinations should be made as the intrathoracic situation is constantly changing and what is not recognizable shortly after the accident may be plainly apparent a few hours later.

#### SUMMARY

1. Severe intrathoracic injuries are possible in children without external evidence and with a minimum of clinical signs.
2. In addition to frequent clinical examinations of the chest in children who have sustained crushing injuries x-ray examination should always be made.
3. Should it be necessary to administer an anesthetic inhalation anesthesia through an intratracheal tube is the method of choice but means should be taken to prevent tension pneumothorax.

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# PERFORATED SOLITARY DIVERTICULUM OF THE TRANSVERSE COLON\*

## CASE REPORT

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THE occurrence of diverticulitis before the age of forty is rather uncommon.

In the transverse colon it is quite unusual. The least frequent complication is acute perforation into the free peritoneal cavity causing diffuse peritonitis. Hence we believe that our patient, who was thirty-five years of age, and had an acute perforative diverticulitis of the transverse colon, was particularly interesting.

That diverticula may occur in any part of the colon is an accepted fact; however, sixty to eighty-five per cent are found in the descending colon and sigmoid.<sup>1,2</sup> It is in this area that almost all of the complications requiring operative intervention arise.<sup>3</sup>

Before the age of forty the incidence of diverticulosis, as given by Bearse<sup>4</sup> is 1 per 1,000 population, for diverticulitis 3 per 20,000 and for patients requiring surgical intervention due to a complication of diverticulitis 3 per 100,000.

The most serious but least frequent complication of diverticulitis is a sudden perforation into the peritoneal cavity causing generalized peritonitis. This is rare, however, perforation and abscess formation being much more common, because peridiverticulitis usually walls off the impending perforation by fixation of surrounding viscera to inflammatory area.<sup>6</sup>

Ochsner and Bagen<sup>7</sup> report a series of patients with diverticulitis in which the incidence of acute perforation was 2.4 per cent. Practically all of the acute perforations occur in the sigmoid or descending colon, although they have been reported

as occurring in the appendix,<sup>8</sup> cecum,<sup>9</sup> and ascending colon.<sup>5,10</sup>

Generally the preoperative diagnosis is that of acute perforative appendicitis. In our patient the preoperative diagnosis of perforated peptic ulcer was made.

When the perforated diverticulum is discovered there is some difference of opinion as to the proper surgical management.<sup>6</sup> Some believe that an attempt to repair the perforation should be made as a certain percentage will be successful. Those which are not successful will develop fistulas similar to the patients who are treated by making no attempt to repair the perforation. Rankin and Brown<sup>2</sup> remove the diverticulum if possible, close the opening loosely with interrupted sutures, and drain the peritoneal cavity. They also perform colostomy proximal to the site of perforation. Others believe that no attempt should be made to repair the perforation, and that incision and drainage is sufficient treatment. The reasons for this attitude are that sutures will not hold in the edematous, infected bowel wall, that the procedure is time consuming and injurious, and that protective barriers are broken down.

We believe that in our patient with a perforative lesion in the mobile transverse colon the exteriorization of the loop containing the perforation was perhaps the best type of management. Exteriorization of the loop is also considered by others to be an acceptable method of treatment.<sup>11,12</sup>

The prognosis, as in other instances of diffuse peritonitis due to perforation of

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abdominal viscera, depends largely on the time interval between perforation and operation.

#### CASE REPORT

H. J. M., No. 4211228, aged thirty-five, white, male, entered the hospital at 10 P.M. on November 8, 1942. At 5 A.M. that morning he had awakened with a burning sensation in his upper abdomen which disappeared after defecation. Then he drank three cups of coffee and at 6 A.M. noticed definite pain in his upper abdomen, generalized, crampy in character, and of moderate intensity. At approximately 6:30 A.M. another bowel evacuation occurred of rather loose, watery material. At 7 A.M. he went to lie down and at 8 A.M. felt slightly better, but took some Alka Seltzer twice with no relief. He arose at 11 A.M., took some Sal Hepatica, had another watery bowel movement, but experienced no relief from the pain and returned to bed. At 2 P.M. he again arose and stayed up and about until 5 P.M. At this time the pain was noticeably more severe and becoming more constant in character. At 6 P.M. he gave himself an enema, and at 6:30 he sat in a hot tub of water for half an hour, neither measure allaying his distress. The pain had now become quite severe, steady, and was located in the upper half of the abdomen. At 8:30 P.M. his physician came and advised his immediate hospitalization.

The patient stated that for ten years prior to his present symptoms, he had experienced aching and soreness in the upper abdomen. At times the distress would be present in the epigastrium, at others in the upper right or left abdominal quadrants. No relationship between these symptoms and the ingestion of food was noted. There was no history of any particular type of food precipitating the distress. When these disturbances began, ten years ago, he would take Alka Seltzer and experience relief for five or six hours. After several years the Alka Seltzer no longer relieved him so he began to use bismuth and magnesia tablets. Hot baths also relieved him.

For the past five years he had had three to four watery bowel movements daily but during this period he had been taking bismuth and magnesia tablets quite constantly.

In 1938, he consulted a practitioner who gave him about thirty colonic flushings at twice-

weekly intervals, and also prescribed a diet. Neither afforded any relief.

In 1941, he went to a charity hospital clinic where x-rays showed "some change" in the stomach. He was advised to attend the ulcer clinic at this hospital, but failed to do so. Instead, he continued his self-medication.

In the past six years he stated that he had lost twenty-seven pounds in weight. His family history was not significant and his only previous illness was typhoid fever at the age of fifteen, from which complete recovery occurred. Use of coffee was excessive, amounting to about fifteen cups daily for the past six years.

Physical examination upon entrance to the hospital revealed a slender, white male, aged thirty-five, appearing acutely ill. His temperature was 100.4°F., pulse 84, respirations 20, and blood pressure 110 over 70.

The essential physical findings were in the abdomen and consisted of marked tenderness over the entire abdomen, but particularly in the epigastrium. Rebound tenderness was generally present, but was also most evident in the epigastrium. Rigidity, generalized and "board-like" in character, was present and no peristaltic sounds were audible upon auscultation of the abdomen. Rectal examination showed no abnormalities.

Blood examination revealed 4,800,000 erythrocytes, 14 Gm. hemoglobin, and 20,250 leucocytes, with 93 per cent polymorphonuclear leucocytes.

The urine was normal and a roentgenogram of the abdomen and chest revealed no free air beneath the dome of the diaphragm.

At 11 P.M., one hour after admission to the hospital, he was taken to the operating room with a preoperative diagnosis of perforated peptic ulcer.

At operation a right paramedian incision, in which the rectus muscle was retracted laterally, was made. Upon opening the peritoneum a large amount of free seropurulent fluid was seen in the abdomen. A mass, the size of a tennis ball, which was thought to be a carcinoma, was palpated in the transverse colon near the hepatic flexure consisting of bowel and adherent omentum. Upon examination of this mass a free perforation of the bowel about 4 mm. in diameter was seen. Around the perforation was a patch of fibrin about 2 cm. in width and perhaps 3 mm. thick. The involved segment was brought out through the

lower part of the incision and the first step of a Mikuliez exteriorization performed.

Postoperatively the patient began to recover satisfactorily and on November 11, 1942, three days after admission, the exteriorized segment of bowel containing the perforation was removed by cauterization. The spur-crushing clamp was then applied and the patient returned to his room.

The patient's postoperative course was relatively uneventful. The spur-crushing clamp was removed from the wound five days after its application and examination of the colostomy showed that the septum had been satisfactorily divided.

The removed segment of bowel was 12 cm. in length with a perforation through the thickened, inflammatory bowel wall near the mid-portion. Upon opening this segment of bowel it was seen that there was a definite evagination in the mucosa at the point of the greatest inflammatory thickening, and that the perforation was located near the tip of this evagination. Thus the gross evidence of a perforated diverticulum was apparent. Besides these changes the surface of the bowel was rough and hemorrhagic, the bowel wall was greatly thickened and opaque with areas of hemorrhage and necrosis. Microscopic sections showed chronic ulcerative inflammation of the bowel with no evidence of malignancy, and in the region of the diverticulum where the inflammatory change was very marked, no muscular coat of the bowel could be seen.

The highest postoperative temperature was 100.4°F. on the fourth day after admission. On the eighth day his temperature was normal and remained so until the fourteenth day after admission when the patient left the hospital. His colostomy was functioning well and the wound was healed.

After leaving the hospital on November 21, 1942, the patient remained ambulatory, ate well, had no digestive disturbances, and gained three pounds in weight. His general condition was good, and on January 7, 1943, he re-entered the hospital to have the colostomy closed. This closure was effected on January 8, 1943, and at this operation the colon was closed and re-introduced into the peritoneal cavity.<sup>a</sup> The peritoneum, fascia and skin were closed in layers as in the usual laparotomy closure. Recovery was uncomplicated, with healing occurring by primary union and the patient

was discharged eleven days after entrance on January 8, 1943.

Since then he has been in good health with no abdominal disturbances. He has stopped his self-medication. Perhaps this is the reason for his freedom from the complaints he had for ten years prior to the onset of his acute diverticulitis.

A barium enema on October 4, 1943, revealed a redundant and tortuous colon. In the proximal transverse colon, just adjacent to the hepatic flexure, there was an irregular annular lesion about two inches in length. The barium passed through this area very readily. This area most likely represents the site of the previous surgical intervention. In addition to this lesion, there was considerable spasm throughout the colon, but otherwise there were no unusual changes. No diverticula could be demonstrated. A film taken after evacuation added no further information.

Fluoroscopic and radiographic examination of the stomach on October 13, 1943, showed no abnormal changes in the stomach or duodenum.

#### COMMENT

Diverticulitis before the age of forty is uncommon. Acute perforation into the peritoneal cavity is the last common surgical complication of diverticulitis. The usual location for diverticula is the descending and sigmoid colon. Diverticulitis usually signifies the presence of multiple diverticula. In our patient we were not able to demonstrate other diverticula by barium enema although they may be present.

In reporting the case of a patient, aged thirty-five, with an acute perforative diverticulitis of the transverse colon, we believe that although this must necessarily be an unusual occurrence, it should be given at least some consideration in the differential diagnosis of surgical lesions in the upper abdomen.

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It should be noted that the so-called umbilical hernia of adult life does not occur through the umbilicus. It is a protrusion through the linea alba just above the umbilicus or, occasionally, just below that structure.

From "A Short Practice of Surgery" by Hamilton Bailey and R. J. McNeill Love (H. K. Lewis & Co. Ltd.).



# SPONTANEOUS RUPTURE OF THE SPLEEN COMPLICATING PORTAL THROMBOSIS\*

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**S**PONTANEOUS rupture of the spleen has been described chiefly in cases in which the spleen is already the seat of some pathological process. The most common of these is malaria. Among the other conditions in which it has been reported are anthrax,<sup>1</sup> bacteremia,<sup>2</sup> Banti's syndrome,<sup>3</sup> brucellosis,<sup>4</sup> echinococcic cyst,<sup>5</sup> Gaucher's disease,<sup>3</sup> hemangioma of the spleen,<sup>6</sup> hemolytic jaundice,<sup>3</sup> hemophilia,<sup>7</sup> Hodgkins disease,<sup>3</sup> kala-azar,<sup>8</sup> multiple plasmacellular myeloma,<sup>9</sup> leukemia,<sup>10</sup> polycythemia vera,<sup>11</sup> as a complication of pregnancy,<sup>12</sup> relapsing fever,<sup>8</sup> sarcoma of the spleen,<sup>3</sup> subacute bacterial endocarditis,<sup>13</sup> syphilis,<sup>3</sup> tuberculosis,<sup>3</sup> typhoid fever,<sup>14</sup> and typhus fever.<sup>15</sup> It may occur in all probability in any condition associated with acute congestion of the spleen. In addition there are described in the literature twenty-seven cases of spontaneous rupture of the spleen in which the spleen has been found to be macroscopically and microscopically normal and in which careful history gave no indication of trauma.

In this paper we are reporting a case of spontaneous rupture of the spleen in a patient with thrombosis of the portal and splenic veins. Portal vein thrombosis without thrombophlebitis may occur in any condition associated with portal hypertension and stasis. Such a condition is most frequently observed in portal cirrhosis but may also be found in stasis due to intra-abdominal pressure associated with neoplastic or inflammatory tumors in the abdomen or inflammation of the gall-bladder or biliary duct system. While

portal thrombosis and associated splenomegaly are common findings in portal cirrhosis,<sup>12</sup> nevertheless, we have been unable to find any such reported case in the literature which was followed by spontaneous rupture of the spleen. Hengeller,<sup>16</sup> reports the case of a forty year old Chinese with carcinoma of the pancreas metastasizing to the liver. He developed a portal thrombosis and died following spontaneous rupture of a chronically enlarged malarial spleen.

The following are two reported cases of so-called spontaneous rupture of a normal spleen in which there was associated thrombosis of the hilar veins (Rhome<sup>17</sup>).

The patient was a white male age twenty-five. Shortly after eating he complained of a sharp pain in the left upper quadrant. He became nauseous and vomited a great deal. On physical examination the abdomen was distended. There was no dullness and no masses were felt. Peristalsis was active. The left upper quadrant was rigid and rebound tenderness was referred to this region. At operation a ragged rent was found in the outer surface of the spleen. The splenic veins were thrombosed. On histological section, the spleen was normal except for thickening and hyalinization of the capillaries. The author expresses the opinion that the thrombosis was of very recent origin and may not have antedated the rupture.

The patient was a twenty-nine year old white female. Her illness had a sudden onset with non-radiating pain in the left upper quadrant of the abdomen. It remained localized for twenty-four hours. At that time the patient complained of epigastric pain and vomited twice. There was no history of trauma or unusual physical activity. On admission to the

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hospital the patient was in shock. There was epigastric tenderness and tenderness in the left lumbar region. The spleen was palpated 2 cm. below the costal margin. The liver edge was not felt. The patient died shortly after admission. At autopsy a tense blue spleen was found which contained a transverse tear 3.5 cm. in length and 0.8 cm. wide. The hilar veins were thrombosed and dilated. Histological sections of the spleen showed congestion and hemorrhage (Zuckerman and Jacobi<sup>18</sup>).

Grey,<sup>19</sup> describes a case in which rupture of the spleen followed thrombosis of the splenic vein. The patient was a forty-six year old woman with carcinoma of the pancreas with metastasis. The neoplasm invaded the splenic vein producing an occluding thrombus.

#### CASE REPORT

M. K., a twenty-nine year old white woman, was admitted to the hospital on October 10, 1942, at 10:25 P.M. The patient weighed about 250 pounds and was 62 inches tall. Her chief complaint was abdominal pain in the right lower quadrant of three weeks' duration. The patient had been in good health until the onset of her present symptoms. For three weeks she had had attacks of moderate, cramp-like pains through out the abdomen but especially in the right lower quadrant. There was no nausea or vomiting but the patient experienced a constant feeling of distention with frequent eructations. Anorexia had been present since the onset and the patient had lost fifteen pounds in the three weeks. The bowel movements were normal. The pain had no relationship to meals and there was no history of any food intolerance.

The systemic review was normal. Menstrual periods occurred every thirty-four days and were of four days' duration. The last menstrual period started on September 26, 1942.

The past medical and surgical history was negative. The patient had one miscarriage in June, 1942.

Physical examination revealed a very obese woman who did not appear acutely ill. The only significant findings were in the abdomen. There was a thick panniculus of fat. There were no scars. No masses were felt. The liver, spleen and kidneys could not be palpated. There was tenderness to deep pressure through out, most marked in the right lower quadrant. Rebound tenderness was not present. The

abdominal wall was soft. Peristalsis was present. Pelvic and rectal examinations were normal. On admission, temperature was 97.6°F., pulse 94, respiration 18, and blood pressure 125/84.

On October 12th, the leukocyte count was 23,200 of which 73 per cent were polymorphonuclear cells, 11 per cent unsegmented leukocytes, 14 per cent lymphocytes and 2 per cent monocytes. The erythrocyte count was 3,790,000 and the hemoglobin was 82 per cent of normal. Urinalyses were negative. The blood sugar was 113 milligrams per 100 cc. and the blood urea nitrogen 10 milligrams per 100 cc. The blood Wassermann and Kline tests were negative.

The patients' complaints did not change during the first and most of the second day in the hospital. At about 3:00 P.M. on October 12th the patient first complained of severe back pain beginning in the lumbar region and radiating around the left costal margin anteriorly. The temperature started to rise slowly and reached 101.8°F. the next day. The abdomen was tender to palpation throughout but now the tenderness was at a maximum on the left side, especially the lower quadrant.

The pain increased in severity throughout the night and the next day, October 13th. At that time rigidity was first noticed over both lower quadrants. The patient seemed prostrate from pain. Blood pressure was 115/74. It was decided to submit the patient to exploratory laparotomy. As she was being prepared, her pulse became very rapid and weak, her skin became cold and clammy, and her blood pressure dropped rapidly. Intravenous saline and a transfusion were started immediately but the patient expired within two hours.

The autopsy findings by Dr. William Antopol, were as follows: The abdominal cavity is filled with a large amount of fluid and clotted blood, measuring approximately 4,000 cc. On inspection the largest mass of blood clot is seen in the region of the spleen. A markedly enlarged spleen is found almost completely embedded in blood clot.

The liver weighs 1,460 Gm., is pale yellowish brown in color and smooth surfaced. On section the glandular architecture appeared well preserved.

The gallbladder and bile ducts are normal.

There is a total occlusion of the portal vein by a red semi-firm thrombus that extends into the splenic vein and into the superior mesen-

teric vein for a distance of about 2 cm. No thrombi were found in other branches of the mesenteric veins.

The spleen is markedly enlarged and weighs 800 Gm. On the surface of the lower half a 6 cm. long tear in a dark bluish somewhat bulging area is noted. This bulging bluish area is about 5 cm. in diameter. At the site of this tear some blood clot is adherent. On the whole the consistency of the spleen is semi-firm, the capsule is not wrinkled and appears thickened. On section the cut surface shows a 5 cm. wide area dark reddish brown in color; the rest is red in color and shows almost all grossly visible vessels plugged with blackish red blood clots. The pulp does not scrape. The follicles are indistinct.

The splenic vein is almost completely occluded by a thrombosis showing beginning organization. The pulp is markedly congested throughout and shows diminished follicle proliferation. Some of the larger parenchymal vessels also show occlusive thrombosis. Diagnosis: Thrombosis of portal, splenic, and superior mesenteric veins; ruptured spleen with hemoperitoneum.

Rankin<sup>20</sup> states that the predisposing factor to spontaneous rupture of the spleen is vascular congestion. When the congestion and increased pressure become sufficiently great subcapsular hemorrhage occurs which progresses to frank rupture. Such a marked congestion may be seen as in our case in which there was a thrombosis of the portal and splenic veins.

Wohl<sup>8</sup> has stated that degenerative changes take place at an early age in a large number of spleens. The arterioles gradually thicken particularly in the media and intima and the capillaries become thickened and tortuous. These degenerative changes, occurring at an earlier age than in other organs, predispose the vessels to rupture when there is marked congestion. According to Grey,<sup>19</sup> the immediate cause of the rupture may be a sudden temporary increase in blood pressure or a sudden muscular action putting the splenic circulation under increased stress.

## SUMMARY

1. A case of spontaneous rupture of the spleen complicating aseptic portal thrombosis is presented.

2. The probable mechanism of rupture of the spleen due to associated splenic vein and portal vein thrombosis is considered.

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## Editorial

### IMPENDING DEATH DESERVES PRIORITY

THE Cadet Nurse on the tonsil cases reports that the last patient with a tonsillectomy and adenoidectomy looks blue and is having trouble breathing; the emergency ward reports a fracture and you can hear the youngster screaming; yesterday's patient with a mastoid operation has a temperature of 105°F. Impending death, pain, clinical disease! Is priority sharp, unmistakable, urgent? Are you familiar with the degree of asphyxia which presents? Do you automatically fall into the correct sequence of treatment? R. C. Adams cites the case of a boy of fifteen years with a little fibroma in his postnasal region who had five or six radon seeds implanted. Pentothal sodium was used and after the operation had been completed the boy became cyanotic and stopped breathing. Dr. Adams visualized the patient's glottis with a laryngoscope and pulled a large clot of blood out of the trachea, which had resulted in a complete respiratory obstruction and which would have caused his death if he had not had the equipment to remove it promptly.

If a patient comes to you complaining of a sore throat, you put a light in his mouth and take a look. The habit and the simple technic of looking into the throat of a patient who cannot get air is easily acquired.

An author, in December, 1933, raised the issue in an article entitled "Asphyxial Death, a Professional Disgrace." In February the Society of the Prevention of Asphyxial Death came into being. In May, the New York Academy of Medicine sponsored the first conference on asphyxia. During the summer, the problem received publicity at the Century of Progress. In 1934, a second conference was held at the Hotel Biltmore in New York City. Leaders in all fields in which asphyxia is encountered presented papers. In less than a year the New York State, the New York County and the A.M.A. approved the aims and purposes of the new Society to prevent asphyxial death. In 1935, an extensive exhibit on asphyxia was held at Atlantic City in conjunction with the A. M. A. In 1936, 1,700 hospital superintendents were invited to act on a nation wide committee to consider asphyxia from the viewpoint of hospital administration. Three hundred thirty-five accepted, twenty of whom directed hospitals of more than 2,000 beds; forty-two states were represented. In the same year the A. M. A. appointed a committee on asphyxia. The committee's report, which was approved by the house of delegates of the A. M. A., appears in the May 1st issue of the Journal for 1937. In 1938, a communication regarding the

treatment of asphyxia neonatorum was addressed to the professor of obstetrics of every medical school of this country and Canada; sixty-three medical schools responded. This response, a new classification for the stages of asphyxia and an acceptable routine treatment were outlined in the *Maine Medical Journal*, January 1940.

In June, 1939, Surgeon General McIntire opened the S. P. A. D. Department of Pneumatology at the New York World's Fair. In 1940, \$6,000 worth of resuscitation equipment was donated to the British war relief by the S. P. A. D. and shipped safely to England. In December, 1941, the special committee on infant mortality of the New York County Medical Society contacted all private hospitals in New York City with the suggestion that arrangements be made with the S. P. A. D. to provide instruction in resuscitation.

Eleven leading hospitals expressed their interest. When the question of an honorarium for instruction was raised, all interest died out. The proposal for instruction was placed before the Children's Bureau, Washington D. C., 1942, and subsequently to the director of Maternal and Child Welfare of every state in the union. The directors of fifteen states responded. But the necessary financing to carry out instruction could not be secured.

In order that the efforts noted above may not perish forever, the writer has included them in a new book entitled the "Art of Resuscitation."

What, it may be asked, has been the practical result of all these conferences, resolutions, approvals, studies and recommendations? It would seem not even a mouse, for today the *average practitioner* is not conversant with asphyxial mortality, is not prepared to render relief in cases of advanced asphyxia, and is not familiar with the stages of asphyxia. The *trained nurse* is not asphyxia conscious and is not trained in methods suited to the care of the unconscious patient. The *average hospital*, municipal as well as private, is not

informed, prepared or organized to deal with asphyxial accidents in accordance with accepted up-to-date methods. The *medical schools* do not integrate the predisposing causes of asphyxiation; instruction, when offered, is subordinated to instruction in anesthesia which is a restricted intramural field.

Such subordination renders relief in accidents occurring outside the operating room illogical, impractical and impotent. Anyone who wishes to take the trouble to confirm the foregoing may do so by making the following inquiries directed to half a dozen practitioners, nurses, hospitals, medical schools and First Aid Squads:

#### *General Practitioner:*

Do you believe asphyxiation to be a serious medical problem?

How do you deal with such cases?

What treatment do you advocate for the various stages of asphyxia?

#### *Nurses:*

What are you taught relative to the care of patients who have difficulty in breathing?

What treatment is advocated for the various stages of asphyxia?

Do you believe asphyxia or suffocation to be an important problem?

Who lectures to you on asphyxia?

#### *Hospitals:*

Who on your staff is called to care for the following emergencies? Carbon monoxide poisoning, a severe case of poliomyelitis, an unconscious patient who is having difficulty in breathing, an electrocuted patient, a victim of chemical gas poisoning, a recently submerged patient, a case of asphyxia or suffocation?

What treatment do you advocate for the various stages of asphyxia in the newborn?

What routine is practiced in patients who return from the operating room following a nose and throat or other operation?

#### *Medical Schools:*

In what department can I secure information regarding the following subjects: Carbon monoxide poisoning, drowning,

electrocution, the asphyxiation of poliomyelitis, suffocation, respiratory obstruction from foreign bodies, drug poisoning leading to unconsciousness, subjects overcome in burning buildings, severe heart failure?

Is the subject of resuscitation taught? By whom?

Who is in charge of asphyxia in the newborn? How are the various stages of this condition met?

*First Aid Squads, Fire and Police:*

Who instructs your men?

Where does the squad secure medical assistance?

What becomes of your asphyxiated patients after the accident?

What stages or degrees of asphyxia do your men recognize?

Impending death from asphyxia would certainly seem to deserve priority over all other considerations; because if we lose life, pain, disability, liberty and the pursuit of happiness are not particularly important.

While the foregoing is in no sense intended as an indictment of the medical and nursing profession, since there are several reasonable explanations for the conditions outlined, nevertheless under the present pressure for medical care those who may claim priority receive first attention. Upon

this basis alone, asphyxial death is without doubt deserving of respectful prompt and skilful attention.

From what has been said, it is fair to conclude that the prevention and the treatment of asphyxia will turn upon the public demand that it be rescued *now, today*, by the following measures which must be freed from competition with lesser evils, as the control of pain and the treatment of disease: (1) Widespread and general knowledge concerning the nature of the problem and its mortality; (2) professional interest aroused to the end that physicians be prepared instantly to meet such accidents along modern lines of treatment; (3) the relegation of resuscitation apparatus to its normal position, as a means instead of an end; and (4) the public insistence that asphyxial death is a grave medical problem of more immediate importance than wounds, hemorrhage, fractures, or constitutional disease.

Priority will be given the prevention of asphyxial death if and when an unmistakable demand for it develops. It will come when the public insists upon prompt, informed and expert medical attention for acute asphyxial accidents.

PALUEL J. FLAGG, M.D.



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# Original Articles

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## GAS GANGRENE IN AMPHIBIOUS WARFARE IN THE PACIFIC AREA

LIEUT. HARRY B. NEEL  
MEDICAL CORPS, UNITED STATES  
NAVAL RESERVE

AND

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GAS gangrene is one of the most serious complications of wounds received in both war and civil life. Our present knowledge of this dreaded infectious process was largely derived from the experiences of the first World War, during which gas gangrene was of common occurrence and interest in it was accelerated. In years of peace anaerobic infections are not numerous and many physicians and surgeons may not be called upon to treat gas gangrene during their entire practicing careers.

The present war has given new impetus to the study of gas gangrene as a complication of war wounds. As experience is acquired by those who care for fresh casualties, and as knowledge is gained and disseminated, it is highly probable that the incidence of this complication can be reduced and the mortality decreased. It seems desirable to record observations which might be of assistance in the prevention, early diagnosis and treatment of gas gangrene and it is for that reason that the seven cases seen in this hospital are reported.

Although Maisonneuve is generally credited with the first description of gas gangrene, in 1853, there has recently been unearthed evidence which indicates that this distinction should go to Fabricius Hildanus. In August, 1607, he wrote a letter to Gregorius Horstius in which he described accurately and concisely a case of gas gangrene in a farmer who had sustained a compound fracture of the leg

when he was run over by a wagon wheel. The clinical course of the infection was carefully observed and recorded. The severe pain, the swelling, discoloration of the skin, crepitus, the formation of blebs, the ascent of the infection up the extremity to the scrotum, the rapid pulse, and finally death while still rational, constitute the picture with which we are familiar today.

Kellett, to whom we are indebted for the correction of this historical inaccuracy, stated that gas gangrene was probably rare before the middle of the nineteenth century. Until the advent of antisepsis the common form was that known as "hospital gangrene" which was complicating approximately 80 per cent of all wounds in some continental hospitals.

In 1892 Welch and Nuttall discovered and isolated the anaerobe now known as *Clostridium Welchii* and which is present in the great majority of cases of gas gangrene. This organism, *Clostridium septicum* and *Clostridium oedematiens* are the most important pathogenic anaerobes and are classified as saccharolytic anaerobes because of their avidity for carbohydrates. They are said to produce lactic and butyric acids, upon which the odor of gas gangrene is dependent, and they produce large amounts of gas. These organisms are gram-positive, spore forming bacilli but each has distinguishing morphological and cultural characteristics.

In 1916, a toxin similar to that of diphtheria and tetanus and with pronounced

hemolytic properties was isolated from the *Clostridium Welchii* and, later, an anti-toxin was prepared which gave complete protection against pure cultures of *Clostridium Welchii* in laboratory animals.

According to Zinsser and Bayne-Jones, *Clostridium Welchii* was present in 80 per cent of all wounds bacteriologically examined during the first World War but only 10 per cent developed gas gangrene. In 72 to 80 per cent of the cases of gas gangrene *Clostridium Welchii* was found. In the Middle East, during this war, McLennan found that 20 to 30 per cent of all war wounds contained sporing anaerobes and in cultures from 146 wounds with gas gangrene the *Clostridium Welchii* was found most frequently. In all other theaters from which reports have been made *Clostridium Welchii* has been the predominating anaerobe. *Clostridium oedematiens* and *Clostridium septicum* have been found rarely.

Firor has pointed out that no cases of gas gangrene have been reported in which there were only anaerobic bacilli. In over one-half of the cases of gas gangrene, aerobic pathogenic cocci and bacilli have been found and it is probable that symbiotic relationships have been established. It is said that streptococci stimulate the growth of *Clostridium Welchii*. There was a mixed infection in each of the cases seen in this hospital but in all cases *Clostridium Welchii* was present.

Since *Clostridium Welchii* normally inhabits the gastrointestinal tracts of man and animals, and because the spore forms may survive for years in soil, it is logical that gas bacillus infections have been associated with wounds contaminated by soil. The infection also occurs in other wounds, however, such as in stumps following amputations for diabetic and arteriosclerotic gangrene. In one case in this small series the patient was wounded aboard a war ship and his wound was contaminated only from his skin and clothes.

In the Middle East the incidence of gas gangrene in war wounds was found by

McLennan to be 0.32 per cent. Collier stated that the infection occurred with "tragic frequency" during the early period of the war in Spain. The incidence in the Dieppe raid is given as 3 per cent and in the Southwest Pacific as between 1.5 and 2 per cent. In 984 consecutive fresh battle casualties treated in this hospital ship, in practically all of which the wounds were incurred in amphibious operations, there were seven cases of gas gangrene, an incidence of 0.71 per cent.

There is a predilection for the large muscle groups since the infection is primarily an infection of muscle. McLennan said that the lower limb was affected in 75 per cent of cases seen in the Middle East. Of the cases seen in this hospital the upper extremity was affected in two (28.5 per cent) cases while in the remainder (71.5 per cent) the lower extremity was the site of the infection.

Some writers have described a localized anaerobic cellulitis as a distinct type of gas gangrene and it is said that in some infections the process has been limited to one muscle or to a group of muscles. Six of the infections observed in this hospital ship were of the fulminating variety, muscles and adjacent structures being involved, and rapid extension was a predominating characteristic.

According to Firor, depending on the virulence of the organism and the amount of devitalized tissue, the incubation period varies from one to four days. In one case seen in this hospital ship it was five days after the injury before signs and symptoms of gas gangrene appeared but the average time elapsed between injury and appearance of signs and symptoms was 2.35 days. Without exception the wounds in the patients with gas gangrene were large, deep, irregular and involved muscle and fascia. In five of the seven cases fractures had been sustained.

#### PATHOLOGY

In traumatized and devitalized muscle whose blood supply has been diminished



or abolished, the pathogenic anaerobes find conditions essential for their growth. In the initial stages of the disease the muscle is dull and opaque. It fails to respond to stimuli, does not bleed when cut and appears lifeless in every respect. Bubbles of gas may be seen to escape when the muscle is cut and on palpation crepitus may be elicited. As gas and toxin are produced by the multiplying organisms, they infiltrate the individual muscles and the groups of muscles, both distal and proximal to the wound, separating the muscle fibers from the interstitial tissue. The swelling and tenseness incident to the gas and exudate cause further ischemia, small blood vessels are damaged and ruptured, and the color of the tissues progresses from dark red to black.

On microscopic examination the muscle fibers are found to be separated from the surrounding interstitial tissue by a clear space. The fibers lose their normal striations, later become coagulated and stain a uniform pink. In some areas the nuclei of the sarcolemma may be present and the normal architecture persists. The sarcolemma later disappears and the coagulated muscle disintegrates. The bacilli are demonstrated in the interstitial spaces and, at a later stage, in the degenerating muscle. Perivascular polymorphonuclear infiltration and thrombosis of the blood vessels are observed.

#### CLINICAL MANIFESTATIONS

Pain, or accentuation of the pain already present, was one of the earliest symptoms in this group of cases. The elevation of the temperature varied considerably. It was rarely alarming and was not consistent with the severity of the infection. In nearly all cases the pulse was hurried and was easily compressible. The patient usually remained unaware of the seriousness of his condition. The pallor and the general appearance of marked toxicity were striking and alarming.

The affected part was swollen, tense and

discolored, and most of the wounds contained necrotic tissue. The discharge from the wound was profuse, was colored by blood and invariably had a foul odor, one difficult to describe but characteristic of gas gangrene. Crepitus was nearly always elicited in the surrounding areas. In five of seven cases the extremity distal to the wound was cool and blue.

The progressive decrease in the number of erythrocytes in the circulating blood was impressive. The erythrocyte count in one patient became as low as 1,900,000 per cu. mm. of blood and in one case the hemoglobin estimation was 5.5 Gm. per 100 cc. The leucocyte count in the cases reported varied between 10,400 and 22,100 per cu. mm. of blood and was not considered to be of diagnostic value.

Savill has said that gas gangrene is often diagnosed too late and suggests that x-ray examination may often result in a more prompt diagnosis. Two types of gas infiltration are demonstrable. In one type the soft tissues are musty or hazy, and full of gas bubbles, while in the second type there are streaks, as of gas between the muscle fibers. Bubbles of air which are carried into the tissues by missiles must not be interpreted as gas produced by gas forming anaerobes. In one case observed in this hospital ship the x-ray film made on admission revealed the presence of gas throughout the leg. The tissue planes were separated by gas and muscle fibers were demonstrated by the infiltration of gas between them. (Fig. 1.)

The mortality of anaerobic infections is notoriously high. From the Middle East McLennan reported a mortality of 50 per cent. In the seven cases observed in this hospital ship two patients died, a mortality of 28.5 per cent. One of these patients was moribund on admission, the infectious process had already spread to his thorax from the stump of a traumatic amputation of the arm, and the patient died within a few hours after being admitted.

## TREATMENT

The most effective prophylactic measure for gas gangrene is early and complete

can be entirely eliminated as a complication of war wounds.

The treatment of established gas gan-



FIG 1 Photograph of x-ray plate of leg in which there was advanced gas gangrene. The tissue planes and the muscle fibers are well outlined by infiltration of gas.

excision of devitalized tissue and thorough cleansing of the wound, into which vaseline gauze is then lightly placed, and the extremity immobilized. Polyvalent gas gangrene antitoxin should be administered to those patients who have large, dirty wounds which involve muscle. The exigencies of modern war prevent the immediate and ideal treatment of all wounds. Therefore, it is unlikely that gas gangrene

is primarily surgical. It should be emphasized that without adequate surgery all other efforts are doomed to failure. In the milder or localized cases all the necrotic and affected tissue must be completely excised so that only viable, well oxygenated tissue remains. Counter incisions help to relieve tension and are of some value. The wound should be left open and tissue planes drained adequately.

Conservative surgical measures, such as the one described above, were applicable in only one case of the seven seen in this

mended by most surgeons. Sulfadiazine and sulfathiazole are the drugs of choice. In the U.S. Army an initial dose of 4 Gm.



FIG. 2. Low power microphotographs of longitudinal and cross sections of muscle from a case of gas gangrene. The fibers are separated by gas, the interstitial tissue is still intact and the nuclei of the sarcolemma are distinct.

hospital ship. In the remaining cases amputation was necessary and was performed through healthy tissue well above the affected area. The stump should be left open with vaseline gauze placed in it and with flaps adequate for secondary closure. It is necessary to observe the stump for evidence of extension of the infection.

Blood transfusions are given liberally. Without multiple transfusions it is doubtful if many of the patients in the fulminating cases would survive. Usually the patient is anemic because of hemorrhage and the hemolysin of the infection further decreases the number of erythrocytes and the hemoglobin in his circulating blood. Whole blood should be administered in adequate quantities regardless of the actual number of transfusions. In the seven patients treated in this hospital ship the greatest amount of blood given to one patient was 3,500 cc., the smallest amount given to one patient was 1,000 cc., while the average amount per patient was 1,900 cc. Plasma was useful in the treatment of shock but it is not an adequate substitute for whole blood in the treatment of gas gangrene.

The administration of a sulfonamide, either orally or intravenously, is recom-

is prescribed and a maintenance dose of 1 Gm. is given every four hours. It is desirable to alkalinize the urine and to provide an adequate fluid intake in order to maintain kidney function.

The value of sulfonamides in the therapy of gas gangrene is equivocal, however. In experimental animals Caldwell found that sulfonilamide crystals implanted in wounds infected with *Clostridium Welchii* seldom controlled or prevented gas gangrene. Page stated that the sulfonamides are on trial and in McLennan's experience sulfonilamide therapy did not appear to be useful in anaerobic cellulitis.

Although serum is not always effective in the treatment of gas gangrene, the polyvalent antitoxin should be administered intramuscularly or intravenously in all cases. It has been recommended that three ampules of the trivalent antitoxin be given every hour until signs of improvement appear. The bivalent antitoxin (*Clostridium Welchii* and *Vibrio septique*) was available in this hospital ship and 20,000 units were given intramuscularly every three hours.

The average dose of gas gangrene antitoxin in McLennan's series of successfully treated patients was between 40,000

and 50,000 units. One patient in this hospital received 300,000 units. Following adequate surgical treatment, on theoretical grounds, it should be necessary to administer only sufficient antitoxin to neutralize the toxin already produced.

Penicillin was used in the treatment of six patients with gas gangrene in this hospital ship. It is not possible to draw any conclusions as to its efficacy because it was only one of several adjuncts to surgery. In other hands results have not been encouraging, toxemia has not been affected and it was thought that fulminating cases could not be saved by penicillin alone.

Many claims have been made for x-ray therapy in the treatment of gas gangrene. A statement of the National Research Council is to the effect that the effectiveness of x-ray in the treatment of gas gangrene has not been established and the use of x-ray therapy in gas gangrene is still experimental.

In Meleney's hands the instillation of a creamy suspension of zinc peroxide into the wound, following careful excision, has given good results both as a prophylactic measure and in the treatment of established gas gangrene. The efficacy of zinc peroxide as a prophylaxis was confirmed experimentally by Caldwell.

#### CASE REPORTS

**CASE I.** A first lieutenant, age twenty-four years, sustained a compound fracture of the right humerus on February 22, 1944. There was a deep, irregular wound which measured approximately 20 by 10 cm. The initial blood count was erythrocytes 2,150,000 per cu. mm., leucocytes 10,400 per cu. mm., and hemoglobin 6 Gm. Following cleansing and débridement of the wound, a hanging cast was applied.

On February 27th the patient complained of pain in the arm. The fingers were swollen, bluish in color and motion was limited. A foul odor was present and crepitus was demonstrated in the lower arm. The temperature had fluctuated between 100°F. and 102.2°F. The pulse rate had shown a tendency to rise.

Under pentothal sodium anesthesia the arm was amputated a few inches distal to the

shoulder joint. The temperature rose to 105°F., the patient became delirious, the pulse rate was 160 per minute and recovery seemed



FIG. 3. High power microphotograph of muscle from a case of gas gangrene. The fibers, the striations of some of which have disappeared, are separated by gas. There are myriads of bacilli between the fibers.

improbable. On the following day there was a marked improvement, however, and the patient made a satisfactory recovery. Direct smears and cultures from the wound yielded organisms which were morphologically and culturally identified as *Clostridium Welchii*.

**Comment.** In this case the incubation period of five days was much longer than the average. The elevation of temperature was not sufficient to cause one to suspect the presence of a serious infection. In retrospect, the persistent rise in pulse rate was significant. Early diagnosis of gas gangrene is dependent upon examination of the wound and surrounding tissues which was prevented in this case by the presence of a cast. Suspicion of gas gangrene was aroused when the patient complained of pain in his hand and lower arm. This was produced by swelling. Despite malignant and extensive spreading gas gangrene of the upper arm, this patient's recovery can probably be attributed to two factors: (1) high amputation of the arm above the involved area, and (2) the administration of a large quantity of blood.

**CASE II.** A private, age twenty-five years, sustained a large, irregular, deep, dirty wound of the right leg which measured approximately 15 cm. in diameter, and a badly comminuted

fracture of the right tibia on February 21, 1944. The wound was cleaned, débrided, left open and a cast applied. Sulfathiazole therapy was instituted by mouth.

On February 23rd the patient complained of severe pain in his leg. The temperature was 104°F. and the pulse rate 118 per minute. A foul odor, and swelling and discoloration of the toes were present. Amputation was performed through the mid-thigh under spiral procaine anesthesia. Smears and cultures from the wound revealed the presence of gram-positive bacilli which were culturally and morphologically identified as *Clostridium Welchii*. Smears from the stump, taken at the time of operation, showed a few scattered gram-positive cocci but culture failed to yield the gas bacillus.

In spite of the administration of multiple transfusions, gas gangrene antitoxin and penicillin, the patient's condition grew steadily worse and he expired on February 26th. The typical subcutaneous gaseous emphysema had extended to the buttock, the flank and lumbar region, and the right lower abdominal wall. Microscopic sections from the stump musculature revealed the characteristic picture of gas gangrene.

*Comment.* In this case also an earlier diagnosis was prevented by the presence of a cast. Because of extension of the infection beyond surgical access, the outcome was unfavorable in spite of very high amputation and the use of sulfathiazole, penicillin and gas gangrene antitoxin.

**CASE III.** A private, age twenty years, was wounded in the right thigh and left arm on February 2, 1944. When the patient was admitted to this hospital on February 3rd he was pale, acutely ill, quiet, responsive. His temperature was 102°F., the pulse rate was 120 per minute and the blood pressure, in millimeters of mercury, was 116 systolic and 90 diastolic. The right upper thigh was swollen, tense, and bluish in color. On the posterolateral aspect of the thigh there was a large wound about 15 cm. in diameter. The skin edges were necrotic, the wound was dirty, fascia and muscle were exposed, there was moderate seropurulent drainage and the odor was offensive. Fine crepitus was elicited. The leucocytes numbered 21,200 per cu. mm. of

blood and the hemoglobin estimation was 7.5 Gm. There were no fractures.

Transfusions amounting to 1,000 cc. of whole blood were administered, 140,000 units of gas gangrene antitoxin were given in divided doses, and sulfathiazole therapy was started soon after admission and continued. Under pentothal sodium anesthesia the foreign bodies were removed, necrotic tissue excised and counter incisions were made anterior to the wound which was left open. Smears and cultures from the wound revealed the presence of gram-positive bacilli identified morphologically and culturally as *Clostridium Welchii*.

The patient improved rapidly and was transferred in good condition on February 10th.

*Comment.* Due to the fact that there was no fracture and no cast had been applied, this patient's wound could be examined readily and easily. The clinical diagnosis of gas gangrene was made early. Radical local excision of devitalized muscle, counter incisions, and thorough irrigation of the wound were possible. It is our opinion that the only way to make an early clinical diagnosis of gas gangrene is by examination of the wound and surrounding tissue, as was possible in this case.

**CASE IV.** A private, age twenty, was wounded in the right arm by shell fragments on February 2, 1944. Because of profound shock it was necessary to administer 1,000 cc. of whole blood, three units of plasma and glucose solution. Guillotine type amputation was necessary elsewhere when the brachial artery burst.

On admission to this hospital on February 3rd at 6:00 P.M. the patient was irrational, the temperature was 102.4°F., and the pulse rate was 120 per minute. The stump of the right arm was open, red, edematous, tender and the end of the humerus was exposed. The muscle was discolored, there was a foul serosanguineous discharge and crepitus was elicited. Blood examination gave the following results: erythrocytes 2,900,000 per cu. mm., leucocytes 20,150 per cu. mm., hemoglobin 8 Gm.

Disarticulation of the shoulder joint was performed rapidly under gas, oxygen and other anesthesia. Counter incisions were made in the pectoral area. Three transfusions of whole

blood of 500 cc. each and several units of plasma were given. The patient failed rapidly and succumbed to the overwhelming infection.

On smears and cultures from the specimen gram-positive bacilli morphologically and culturally identified as *Clostridium Welchii* were demonstrated.

*Comment.* Although this patient was irrational on admission and the infection had spread to the shoulder girdle, after suitable supportive treatment had been given, a disarticulation of the humerus and incisions in the pectoral region were performed in order to give him the maximum chance of recovery. When the infectious process has spread beyond surgical access the prognosis is extremely grave.

CASE V. A private age twenty-two years, was admitted to this hospital a few hours after being wounded by fragments in both lower extremities on February 22, 1944. The wounds of the thighs were deep, irregular, 10 to 12 cm. in diameter and muscle was exposed and macerated. There were smaller wounds of both legs and a comminuted fracture of each tibia.

Casts were applied following treatment on shock, cleansing and débridement of the wounds and reduction of the fractures. On February 24th the patient complained of severe pain in the left leg and he appeared toxic. The temperature was elevated to 102.6°F. but the pulse rate was only 98 per minute. The odor from the cast suggested the presence of gas gangrene. Swelling and cyanosis of the toes were observed.

Amputation through the left mid-thigh was performed under spinal anesthesia. Vaseline gauze was placed in the wound and the flaps were only partially closed. In the surgical specimen typical subcutaneous gaseous emphysema was demonstrated and direct smears and cultures revealed the presence of gram-positive organisms morphologically and culturally identified as *Clostridium Welchii*.

In the course of treatment 1,500 cc. of whole blood, 1,500 cc. of plasma, 140,000 units of gas gangrene antitoxin and 200,000 units of penicillin were administered. On February 25th examination of the blood gave the following results: erythrocytes 2,280,000 per cu. mm.; leucocytes, 11,400 per cu. mm.; and hemoglobin 5.5 Gm. Convalescence was satisfactory.

*Comment.* In the presence of a cast, pain around and below the wound, and swelling and discoloration of the toes in the lower extremity, or the fingers in the upper extremity, are signs suggestive of gas gangrene, as illustrated by this case. Also, in this case, the temperature was not in proportion to the severity of the infection.

CASE VI. A seaman, age twenty years, was struck in the left leg by a shell fragment while aboard his ship on February 22, 1944. He sustained large wounds in which the muscles were torn and shredded, and comminuted fractures of the tibia and fibula. The wounds were thoroughly trimmed, débrided, and irrigated. Following reduction of the fractures by traction, a padded cast was applied to the leg and thigh.

On February 24th the temperature was 102.4°F.; the pulse rate varied between 120 and 140 per minute. Although the case had been split, the toes were cool and cyanotic. The odor of the profuse drainage was foul. Under a combination pentothal sodium and spinal anesthesia, amputation was performed through the lower thigh. In the specimen there was subcutaneous gaseous emphysema, and gram-positive bacilli, morphologically and culturally identified as *Clostridium Welchii*, were demonstrated.

Improvement was progressive but complicated by a mild febrile reaction. On February 26th the erythrocytes numbered 1,900,000 per cu. mm. of blood, the leucocytes 11,200 per cu. mm. and the hemoglobin was 8 Gm. The patient had received 3,500 cc. of whole blood, 2,250 cc. of plasma, 300,000 units of gas gangrene antitoxin and 300,000 units of penicillin. He was in good condition when transferred on March 3rd.

CASE VII. A private, age twenty-one years, was wounded in the right thigh and both legs on February 1, 1944. His wounds were cleaned and a cast applied.

When the patient was admitted to this hospital on February 3rd he was pale and irrational. The temperature was 99.8°F.; the pulse rate was 112 per minute. The cast, which had been split, was saturated with dark, bloody, foul drainage. The erythrocytes of the blood numbered 2,630,000 per cu. mm., the leucocytes, 22,100 per cu. mm. and the hemoglobin

estimation was 9 Gm. Roentgenologic examination showed a comminuted fracture of the shaft of the right tibia. The tissue planes were separated by gas which had penetrated between the muscle bundles so that individual bundles were demonstrated.

Amputation was performed through the upper thigh under spinal procaine anesthesia. The foot and leg were found to be gangrenous. There was an extensive irregular, dirty, foul wound on the anterior surface of the leg from which gram-positive bacilli culturally and morphologically identified as *Clostridium Welchii* were obtained.

Before and after operation a total of 2,000 cc. of whole blood was administered; 80,000 units of gas gangrene antitoxin and 100,000 units of penicillin were also given. There was continuous improvement. When the patient was transferred on February 11th he was in good condition.

*Comment.* Most interesting in this case is the fact that the temperature on admission was only 99.8°F. although there was extensive gas gangrene of the leg as demonstrated both clinically and on roentgenologic examination.

#### SUMMARY AND CONCLUSIONS

1. In 984 consecutive fresh battle casualties there were seven cases of gas gangrene, an incidence of 0.71 per cent.

2. The lower extremity was the site of the infection in five cases (71.5 per cent) while the upper extremity was involved in two cases (28.5 per cent).

3. In all cases a gram-positive bacillus morphologically and culturally identified as *Clostridium Welchii* was found.

4. The incubation period varied from one and one-half to five days. The average time elapsed between the injury and appearance of symptoms was 2.35 days.

5. The wound in each case was large, deep, irregular and involved muscle. In five cases fractures were present and in one case amputation had previously been performed.

6. In nearly all cases pain was the initial symptom. Two patients were de-

lirious on admission to this hospital. Local swelling, discoloration, crepitus and foul odor are early diagnostic aids. Evidence of toxicity appears late in the course of the disease.

7. A persistent elevation of the pulse rate was observed. The temperature was not a reliable index to the severity and extent of the infectious process.

8. The low erythrocyte counts and the low hemoglobin content were probably the most striking laboratory findings.

9. In one case the diagnosis was confirmed by the x-ray picture.

10. The treatment, both prophylactic and therapeutic, is primarily surgical. Early care of wounds and excision of devitalized tissue may reduce the incidence of gas gangrene.

11. In one case of gas gangrene excision of the wound gave satisfactory results. In six cases amputation was necessary. Wounds should be left open and vaseline gauze placed in them. Spraying of the stump with microcrystalline sulfathiazole, as recommended by many surgeons, is the practice in this hospital ship.

12. In patients with wounds of the extremities which are obscured by casts the early diagnosis of gas gangrene is difficult. The patients should be questioned frequently concerning the presence of pain. The cast should be examined for the odor characteristic of gas gangrene and swelling below the cast should arouse suspicion.

13. Multiple transfusions of whole blood were considered the most valuable single adjunct to surgery.

14. There were two deaths, a mortality of 28.5 per cent.

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SYMMETRICAL gangrene is a trophoneurosis due to spasm of the arterioles with recurrent vasomotor attacks, characterized by local arterial syncope, usually bilateral and symmetrical, affecting the fingers and toes, and excited by cold or systemic states causing a superficial capillary anemia.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea & Febiger).



# CARCINOMA AND LYMPHOSARCOMA OF THE COLON

## A CASE OF LYMPHOSARCOMA OF THE DESCENDING COLON

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THE term "malignancy of the colon" has been employed frequently by surgical writers and they usually have meant thereby carcinoma. Lymphosarcoma, however, does occur and this fact should be borne in mind particularly in suspected carcinoma with atypical manifestations. I have recently encountered a case of lymphosarcoma originating in the descending colon and thus my attention has been drawn for the first time to this extremely rare condition. In choosing a title for this paper I have included lymphosarcoma as one of the malignant colonic tumors rather than have it lost sight of in the general term "malignancy of the colon."

### CARCINOMA OF THE COLON

The literature on this subject has increased enormously in the last five to ten years. I believe that this is largely due to the realization by the profession of the increasingly favorable results of its surgical treatment. Not only is the operative mortality being steadily lowered but the percentage of five-year cures is mounting. In the latter respect, cancer of the stomach makes a poor comparison indeed. It is understandable that a condition offering a better and better prognosis from improved diagnosis and treatment, should stimulate the interest of the surgeon and encourage him to still greater efforts to improve his treatment of this serious disease. The internist, too, who has in the past been perhaps too pessimistic over the outlook for a patient with cancer of the large bowel, has also taken a fresh interest and come to realize that an early diagnosis, and hence early operation mean a 50 to 60

per cent chance of a permanent cure. Cancer of the colon has an inherently better prognosis than cancer of the stomach on account of its slow growth and slow metastasis. Furthermore it can be radically removed together with a large section of bowel without impairment of function of the remaining bowel. Earlier diagnosis has been made possible by education of the laity in cancer in general and greater alertness of the profession in suspecting and discovering the disease early. Diagnostic aids, including x-ray and sigmoidoscopy have developed greater efficiency and thus made earlier diagnosis and thus earlier operation possible.

Perhaps the most important factor in the improvement of our operative results has been the greater attention paid to the pre-operative preparation local and general. In the absence of acute obstruction which unfortunately is in many cases the first symptom that brings the patient to the surgeon, much can be done to prepare the colon for operation. Many patients have chronic obstruction and stasis which can be overcome by colonic irrigations, mild saline catharsis or possibly cecostomy. The dehydration so frequently present can be remedied by intravenous infusions; anemia and general weakness by transfusions. Such preparatory measures lasting sometimes several days improve our operative results very materially and should never be neglected. Operative technic has also improved and been made safer. Resection and immediate suture have given way in most clinics to stage operations which have a much lower operative mortality. Whether preliminary vaccination of the peritoneum has lowered the incidence of postoperative

peritonitis, is a debatable question. The internal use of sulfanilamide and more recently sulfaguanadine preoperatively is being tried in some clinics, apparently with a favorable effect on the prevention of postoperative peritonitis.

The most important factor in improving still further the prognosis is earlier diagnosis. Statistics show that even now with our improved diagnostic measures, the disease has usually been present for a year before reaching the surgeon. The problem is to shorten this period. The improvement in prognosis will well repay our efforts. As a preliminary to the discussion of diagnosis, it may be well to consider the important pathological factors of this condition and its chief clinical manifestations.

As regards incidence we find that it represents about 15 per cent of all cancers (U. S. Bureau of Census). It is almost as frequent as carcinoma of the stomach.

It is definitely a disease of later life. Pennington analysed 7,313 cases and found that 4,886 were in individuals over fifty years of age. The statistics agree that it is found more often in males than in females. Friedenwald<sup>1</sup> in his group of one-hundred cases had sixty-one males and thirty-nine females. Dixon<sup>2</sup> reported that in the Mayo Clinic there had been twice as many cases in males as in females.

*Location.* Carcinoma has been found in every section of the large intestine but it has a predilection for certain areas. Steindl reported 175 cases and Wilkie 243 cases with the following classifications:

Steindl	Per Cent	Wilkie	Per Cent
Sigmoid.....	49.1	Sigmoid.....	51.4
Cecum.....	20	Cecum.....	6.9
Hepatic flexure.....	8.6	Hepatic flexure....	2
Splenic flexure.....	6.9	Splenic flexure....	4.9
Ascending colon.....	6.3	Ascending colon...	12
Descending colon....	5.1	Descending colon...	8.2
Transverse colon....	4.4	Transverse colon..	9.4

in the cecum and ascending colon. It is thus evident that the left colon, particularly the sigmoid is affected twice as often as the right colon. As in all cancer of the alimentary tract the favorite location is in areas subjected to traumatic or irritative influences, in natural or unnatural flexion angles and in the areas of spastic contraction. The sigmoid belongs in at least one of these categories. Another predisposing factor is the existence of a polyp in the mucous membrane. Some authorities claim that this is the most common starting point of the cancerous development. Another etiological factor may be chronic ulcerative colitis. The Mayo Clinic reported twenty-five such cases. There is a striking difference in the pathological status of carcinoma between those in the right and those in the left segment of the colon. This is due to anatomical and physiological factors. The right side of the cecum to the middle of the transverse colon has a function chiefly of absorption. The feces are liquid and they contain organisms of high virulence and extremely noxious toxins. The fluid contents are a good culture medium for bacteria. Furthermore this area of large intestine is rich in lymphatics, which means more absorption into the general system. The left side, on the other hand is the storage segment and contains formed feces from which the fluid has been extracted in the right segment. The lymphatic supply is scanty and the organisms are less virulent on account of the fact that the inspissated fecal collection is not a favorable field for growth of bacteria.

There are four common forms of carcinoma found in the colon: (1) The crater form *ulcer* which begins as an elevation of the mucosa on one side of the bowel and which grows in a circular direction surrounding and constricting the lumen. The edges pile up, overhanging an excavated ulcer; (2) a friable *cauliflower* growth rarely encircling the bowel but producing partial or complete obstruction by encroaching on the lumen; (3) polypoid or pedunculated

In Allen's series of 634 cases there were 53 per cent in the sigmoid and 25 per cent

growths which do not produce symptoms of obstruction, and (4) small *constricting* (*napkin ring*) tumors usually of the scirrhus type. They rarely ulcerate, but infiltrate the bowel wall producing a small constricting ring.

The ulcerating tumors and the cauliflower-like growths are more frequently seen on the right side. The small annular constricting napkin ring growths are characteristic of the left side tumors, particularly in the sigmoid. On account of this condition and the fluidity of the feces, tumors on the right side rarely produce complete obstruction, whereas those on the left, particularly those in the sigmoid, cause a bowel closure very promptly. Cancer of the large intestine frequently spreads to other tissues or organs, such as the omentum, stomach, small intestine, parietal peritoneum, abdominal wall and bladder. The mesenteric lymph glands are usually the first sites of secondary growth. Metastasis in the liver rarely occurs in right-sided cancer, but is more common in those on the left side. In general, however, carcinoma of the colon has a low grade malignancy. It spreads very slowly and metastasis comes late. This means that for a long period in its development cancer of the colon remains a local lesion suitable for removal. In 210 cases which came to autopsy, 113 showed either no metastasis or only a few enlarged regional lymph glands. Perforation of the wall of the colon by the ulcerating growth sometimes occurs causing an abscess. Fistulous connection may also take place with a neighboring organ such as the small intestine, bladder, or stomach. Borgen,<sup>3</sup> in a study of 1,502 operative cases, noted an occurrence of perforation in 9.3 per cent.

As regards comparative malignancy, Grinnell has found four criteria for histological grading to be of value: (1) glandular arrangement, (2) invasiveness, (3) nuclear polarity, and (4) number of mitoses.

Duke classified carcinoma of the colon as A, B, and C, in degree of malignancy. The chances of a five-year survival without

recurrence was four times as good for the class A cases as for the class C cases. The incidence of metastasis increases with the grades. The number of five-year survivals after operation was two and a half times higher when the glands were not involved.

Carcinoma of the colon in its early development does not give rise to definite clinical symptoms. In this respect it is at a disadvantage compared with carcinoma in other organs, and as compared with inflammatory lesions in the colon. In general a year has elapsed before the patient is operated upon. Occasionally, a carcinoma of the colon has been accidentally discovered in the course of an abdominal operation for some other lesion. The delay in making the diagnosis may be shortened by education of the laity in the importance of early consultation of a physician for unusual gastrointestinal symptoms. The physician for his part should emphasize in his mind not those symptoms which are pathognomic of carcinoma of the colon but rather the indefinite ones that *might* be caused by carcinoma. In most cases these may be caused by some other condition and a thorough examination may be negative for carcinoma. Nevertheless the wise physician will insist upon a thorough examination of every patient particularly over forty who has persistent abdominal symptoms even though vague and slight in character, which do not disappear under the usual dietetic and medicinal measures. The symptoms may consist of a feeling of abdominal pressure, especially on the right side, colicky pains or gaseous distention. Loss of appetite which usually accompanies all gastrointestinal carcinoma together with a feeling of pressure in the upper abdomen may lead the physician to think first of a stomach condition, which with a negative x-ray of the stomach is diagnosed as an inflammatory disease of the stomach and treated as such without benefit. Of more importance is painful distention of the cecum and ascending colon which may lead to the diagnosis of appendicitis and operation. This error in diagnosis is more

likely to occur if a history of increasing constipation is not taken into consideration. This painful distention on the right side should be looked upon as an important sign, especially in elderly individuals and not immediately diagnosed as appendicular in origin. It should indicate the necessity of careful examinations including sigmoidoscopy and x-ray. The appearance of anemia in an elderly person is significant especially of carcinoma of the right colon. Such an anemia should not be treated as such until malignancy of the colon has been excluded.

The usual symptoms which bring patients with carcinoma of the colon to a physician are persistent abdominal pain, visible blood in the stools or changes in the bowel habit particularly increasing constipation. Each of these symptoms are an indication for a thorough examination. Lahey<sup>4</sup> found a history of a change of bowel function in 80 per cent of his cases of carcinoma of the left colon and rectum. Colicky pains, especially in an elderly person, can be caused by beginning obstruction. Increasing constipation in the elderly patient should be looked upon with suspicion and not treated by stronger cathartics, until carcinoma has been eliminated. Alternation of constipation and diarrhea occurs in a certain percentage of the cases, especially in the pelvic colon. Lahey<sup>4</sup> found it in 8 per cent of one hundred cases. Stools should be examined for visible and occult blood. Active bleeding is rare. Blood from a carcinoma of the right colon is usually mixed with the stool but when originating from the left colon is attached to the stool or appears as bloody mucus. Friedenwald<sup>1</sup> found blood in the stools of 24 per cent of his cases as an early symptom and in 52 per cent of the later cases.

The presence of a palpable tumor is usually a late symptom. It is more often in carcinoma of the cecum and ascending colon. This is due to the fact that this area is more easily palpated and further-

more the right-sided tumors are usually larger.

As the pathological status of tumors of the right and left colon shows marked differences so does the symptomatology. Dyspeptic symptoms are more characteristic of right-sided carcinoma. This is frequently associated with pain or discomfort on the right side suggesting appendicitis or cholecystitis. In fact, many patients are operated upon with these diagnoses. In other cases anemia is the first symptom that brings the patient to the physician. Such an anemia which cannot be otherwise explained should be looked upon with suspicion especially in an elderly individual and calls for a thorough examination of the entire colon including x-ray. This anemia is not caused by loss of blood but is toxic in origin. In a third group of cases the presence of a tumor in the right iliac fossa is the first symptom and may be first discovered by the patient. On the left side obstruction is the outstanding symptom. It has been estimated to occur six times as often as on the right. This is easily understood when we consider first that the feces in the left colon are more solid and thus have greater difficulty in passing even a moderately obstructed lumen. Furthermore, as has been stated in connection with the pathology, left-sided carcinoma is often of the constricting (napkin ring) type which produces annual closure of the bowel.

The obstruction may be acute and sometimes is the first symptom of the disease. Acute total closure of the bowel is, however, exceptional. Authors differ considerably in the percentage of cases with acute obstruction. Figures range from 5 per cent (Rankin<sup>5</sup>) to 27 per cent (Finsterer<sup>6</sup>). This divergence may be partially explained by a different interpretation of the term "acute obstruction." Some surgeons mean, thereby only complete obstruction and others include cases of incomplete obstruction. Acute partial closure is more common and should be treated in the same way as complete obstruction, viz., by immediate

operation. Acute complete obstruction should be diagnosed when there is total stoppage even to the passage of flatus with marked distention of the abdomen, hyperactive peristalsis causing spastic and even visible contractions of the afferent bowel and vomiting later becoming fecal. Such an acute obstruction may come out of a clear sky or it may be grafted on to a chronic obstruction. Cases are on record in which barium from a gastrointestinal series has plugged the colon at the site of an annular lesion and thus precipitated an acute obstruction. As a general rule obstructions from carcinoma of the left colon are slow and likely to be progressive, causing gradual deterioration of health by intoxication and dehydration. Patients in such a condition react very badly to operative procedures even of a minor character and when possible should be first brought into a more favorable state before any operation is attempted. It is often astounding to see the improvement that results from the medical measures that are used to overcome the obstruction, intoxication and dehydration.

The diagnosis of carcinoma of the colon is comparatively easy in its later stages, but may be very difficult in its early development when surgery offers the greatest hope. There being no characteristic symptoms of beginning carcinoma of the colon the physician should not rely upon any one symptom, but rather upon an impression based on a number of factors in the history, symptomatology, physical examination, laboratory reports and x-ray examinations. In the history, age of the patient, the mode of appearance of abnormal symptoms (perhaps in a previously healthy person) loss of weight, anemia, indefinite dyspeptic symptoms, periods of obstruction, blood in the stools, change in bowel habits, are all important factors to be carefully considered. The presence of such a group of manifestations calls for a careful and complete physical examination. Here the presence of a tumefaction is, of course, of the greatest importance. Such a

tumor is most likely to be found in the region of the cecum or ascending colon. It must be remembered that a tumor in the cecal region may be caused by a chronic appendicular abscess. There is the same irregularity, firmness and low degree of tenderness that is found in a carcinoma of the cecum. This mistake has been made many times. The opposite can also happen. What was thought to be an old appendicular abscess has turned out to be a carcinoma of the colon with secondary inflammatory changes. The laboratory may show microscopic blood in the stools and a definite anemia. A rectal examination should never be neglected and gives invaluable information regarding the presence or absence of a neoplasm in the rectum and rectosigmoid. X-ray examination should follow and may prove conclusive. One should not, however, rely upon one examination, particularly a negative one. The x-ray enema should be first employed as any obstruction already present might become acute and give rise to alarming symptoms if a gastrointestinal series was the first procedure.

It may be said in general that an important positive x-ray sign of a carcinoma is a narrowing found constantly present at a definite point in the colon which remains visible in spite of manipulation or the insufflation of air after the expulsion of the barium enema. A second positive sign is a persistent irregularity in outline of the colon especially when accompanied by spasm. Distention of the colon with air after the barium enema has been expelled sometimes brings out more clearly a lesion that has been masked by the barium. Complete reliance must not be placed on a negative x-ray examination if other symptoms strongly suggestive of carcinoma of the colon, persist. It has not infrequently happened under these circumstances that an exploratory operation has revealed a carcinoma in spite of repeated negative x-ray examinations. The diagnosis of simple spasm of the colon should not be made on the basis of a single x-ray examination.

Before the second examination atropin should be given. If the narrowing of the lumen is still present, the stricture is probably organic in nature. Lesions of the rectosigmoid junction are frequently not visualized by x-ray. For this reason sigmoidoscopy should be employed in addition to x-ray when malignancy is suspected in this area. Diagnosis of carcinoma of the colon will be made at a much more early date if middle aged and elderly patients are educated to seek advice for any change in bowel function, especially increasing constipation with or without mucous diarrhea. These patients should also be educated to submit readily to x-ray examination with barium enema and to proctoscope examination. Unfortunately the cost of x-ray examination is still high. It should be brought down to such levels that examinations can be made as a routine in all doubtful cases. There will of course be a great many negative examinations if this policy is carried out, but on the other hand physicians must realize that only by routine examinations of all kinds can they discover early cancer of the colon.

In considering the prognosis of carcinoma of the colon it should be noted that there are some factors that are favorable to successful surgical treatment and others unfavorable. As already emphasized carcinoma of the colon develops slowly and hence if discovered at a reasonably early stage is capable of successful removal. Furthermore it usually remains localized for several months thus making radical and complete eradication feasible even in a late stage. Finally carcinoma of the colon involves an organ, a large section of which can be removed by a comparatively simple and safe technic without impairment of function. Among unfavorable factors in prognosis the most important is the fact already emphasized in the symptomatology, viz., that there is usually a latent period in which there are no characteristic symptoms on which a definite diagnosis can be made. As a result, a year has usually elapsed before the patient comes to opera-

tion. The loss of this valuable time constitutes a serious handicap at the start of the radical treatment. Another handicap is the infectious content of the bowel combined with the tendency to gaseous distention which renders primary anastomosis dangerous.

The prognosis has undoubtedly improved greatly in recent years and for this several factors are responsible. In the first place there is earlier recognition and hence earlier treatment. Prognosis following operation has been greatly improved by the more general recognition by surgeons of the immense importance of preoperative treatment of the patient and by greatly improved technic of operative and post-operative care including the introduction of the much safer multiple-stage procedures. The prognosis of carcinoma of the right colon is better than of the left. Carcinoma of the right colon seldom gives rise to liver metastasis while this is not an uncommon complication on the left side. Furthermore, operation on the right colon is less complicated and safer. Age has an important influence on the prognosis. It is very malignant in the young. Carcinoma in a patient sixty years old has a better prognosis than in one fifty years old. This is largely true because metastasis is slower as age advances.

The diagnosis having been made the first question to be decided by the surgeon is that of operability. Here again the last few years have seen a marked improvement. Formerly, the diagnosis was made very late in the disease and a majority of the cases had become inoperable on account of extensive local and general metastasis or cachexia. Finisterer<sup>6</sup> has recently reported an operability of 79 per cent of the cases applying for radical treatment. Babcock estimates operability at 60 to 80 per cent. The surgeon is not seldom surprised to find on opening the abdomen that a tumor which on external and x-ray examination had appeared very large and apparently involved an extensive area is actually localized and capable of complete

removal. It may be necessary to resect adjacent structures such as the stomach or small intestine which have become invaded. A preliminary colostomy with delay in carrying out the radical operation will often improve the local condition about the tumor. The inflammatory infiltration in the intestinal wall and adjacent structures subsides, the growth diminishes in size and becomes more movable and complete excision becomes possible.

Except in the case of acute obstruction all operative measures should be delayed until the patient has been put into a condition to withstand their effects. Even a colostomy for partial obstruction may prove fatal in a weak, dehydrated individual who has suffered for a long time from chronic obstruction, anemia and inanition. When delay is possible, preoperative measures should be carried out in full. If partial obstruction is present, this can usually be relieved by repeated saline enemas, mild catharsis and hot abdominal stupes. If there is no obstruction present, the intestines should be emptied of fecal matter by a combination of mild catharsis and colonic irrigations. The patient should be given a high caloric, non-residue diet. The water balance should be re-established by saline, bicarbonate or glucose in large quantities given preferably intravenously or by clysis. A diminished glycogen content of the liver may require the administration of sugar. Vitamin therapy may be indicated. In case anemia is a symptom one or more transfusions of blood should be given just before operation.

A discussion of the various operative methods employed for the removal of carcinoma of the colon will not be attempted in this paper. Certain general principles, however, will be laid down. Here again a distinction should be made between the right and left half of the colon. Primary resection of the right half is much safer than of the left. This procedure on the left side has been largely given up on account of the danger of leakage at the point of suture. This difference is chiefly due to the

fact that the solid contents of the distal colon tend to put too much strain on the suture line. A preliminary right-sided colostomy diminishes this danger to some extent. The general custom has been to perform on the right side a one-stage resection of the colon. Of late some surgeons prefer a two-stage operation on account of greater safety. Allen for example reported seventy-three right-side resections in one stage with twenty per cent mortality and eighteen two-stage resections with 11 per cent mortality. On the left side some form of exteriorization method is the usual procedure. This takes the form of the Mikulicz technic or some modification.

The present end results of operation are distinctly encouraging. Dixon reports from the Mayo Clinic 52 per cent of the patients operated upon for carcinoma of the cecum alive and well five or more years later. In carcinoma involving the colon from the cecum to the sigmoid, the five-year cures were 48 per cent. As regards operative mortality Rankin has recently reported 130 cases with 8.4 per cent mortality. The figures both for operative mortality and five-year cures given by the more experienced operators certainly show a great improvement over the statistics of twenty years ago. This gain is due to (1) earlier diagnosis and hence earlier operation, (2) more thorough preoperative measures, and (3) improved and safer technic. Carcinoma of the colon has become one of the most hopeful of the intra-abdominal malignancies and bids fair to become even more so now that it is receiving increasing attention from the physician, the surgeon and the laity.

#### LYMPHOSARCOMA

Lymphosarcoma of the intestine is rare. Reichel found thirty-three cases in 54,000 autopsies. Nothnagel found nine cases in 21,358 autopsies. Involvement of the colon is less frequent than that of the small intestine. Ullman,<sup>7</sup> in a study of 126 cases found the small intestine the primary site in seventy-seven cases, the colon including

the cecum in thirty-two cases and the ileocecal region in eight cases. The cecum was the primary site in seventeen cases, the ascending colon in two, the transverse colon in one, the descending colon in two, and the sigmoid in four. The right colon is apparently more often involved than the left.

Authorities agree that the disease is more common in males. In Ullman's series there were ninety males and thirty-six females. In contrast with carcinoma it is found most commonly in the first four decades. It is especially common in childhood. Cases in older people do occur. Werden reported a case in a woman eighty-four years old. The case reported in this paper was a woman of seventy-three. The cases occurring in childhood have a very rapid course. Those in the older individuals are characterized by a very slow course. One reported case states the patient lived for twelve years.

The pathological origin of the disease as stated by Ewing<sup>8</sup> is in the lymphoid tissue of the intestinal wall (submucosa). The process here spreads laterally, and invading and destroying the muscular coat, may cause a bulging of the mucosa into the lumen and a protuberant swelling beneath the serosa. Perforation of the mucosa causing ulceration is not the rule. Likewise perforation of the serosa is unusual. Adhesion, however, with adjacent structures (omentum and other intestines) may occur. Cicatricial narrowing of the intestines as in carcinoma does not occur but rather a dilatation of the wall as in aneurysm owing to loss of function of the muscular layer. Stenosis is rare. Metastasis takes place early in the mesenteric lymph-glands and omentum. These secondary tumors may reach a large size and overshadow the original growth in the intestinal wall. A chronic peritonitis with fluid is not infrequent.

The symptoms caused by the development of a lymph sarcoma of the intestines are not characteristic. The diagnosis is scarcely ever made before operation or

autopsy. General symptoms such as anemia, loss of strength and of weight may be the first evidences to the patient and physician. In other cases local symptoms may be the first to appear, such as abdominal pain sometimes of a colicky nature. This pain is not associated with the intake of food or disturbances of bowel function. There may be constipation or diarrhea or alternation of each. Acute obstruction of the intestine is rare and is caused by intussusception, adhesions or plugging of the lumen. The presence of a mass in the abdomen, particularly the lower segment, is a common finding and may be the first thing that attracts the attention of the patient or physician. Anemia is a constant symptom and may be accompanied by a moderate leucocytosis and increased polynuclear count.

As already stated the diagnosis is hardly ever made before operation. Even x-ray is not very helpful. Where the small intestine is involved, there may be seen some dilatation of loops of small intestine with a tendency to local stasis. If the colon is involved, a barium enema may show a deformity or filling defect. Exploratory laparotomy is the usual method of making the diagnosis and should always be employed when there is a palpable tumor with evidences of intestinal obstruction and particularly when associated with an unexplained secondary anemia with loss of weight and strength. The best hope of cure lies in early and radical operation. Resection of the portion of intestine involved has been followed in some cases by complete cure. When metastasis in the mesenteric lymph glands and omentum have occurred with adhesions and possibly ascites, radical removal is impossible. In such cases some form of palliative operation will be done, such as short circuiting or permanent colostomy. If the obstructive symptoms are not marked simple closure of the abdomen may be the procedure of choice. Irradiation is advised by some authors both after radical, palliative and simple exploratory operation. Theoretically



this seems indicated on the ground of its favorable effect upon lymphosarcoma in general. Practically, the results have not been encouraging. Many of these patients are very debilitated and do not react well to this treatment. Others have shown no local improvement. It should not of course be considered a substitute for radical surgery.

The following case of lymphosarcoma of the descending colon has recently been under my care, and the rarity of the condition would seem to justify a report of the case:

#### CASE REPORT

The patient was a female, seventy-three years of age, from whom I had removed a simple ovarian cyst five years before. She had been in good health since the operation when she consulted me on account of a swelling in the lower left quadrant of the abdomen which had been discovered in another city a few weeks before, and for which an operation had been advised. For the preceding year she had been treated for anemia, constipation and loss of weight and strength. She had had some pain in the left lower quadrant.

Examination showed a thin anemic woman with a median laparotomy scar. The abdominal wall was very thin and relaxed and a hard irregular swelling the size of a small orange could be easily felt in the region of the lower descending colon. X-ray showed no definite obstruction of the intestine but some irregularity in the wall of the colon. On account of her age, anemia, loss of weight and strength and the presence of a tumor, a diagnosis of carcinoma of the descending colon, was made and operation advised. Operation revealed a hard nodular tumor involving the descending colon and adherent to the parietal peritoneum. There was a secondary tumor the size of an English walnut in the omentum. There were enlarged glands in the mesentery. A portion of the left rectus muscle adjacent to the growth was the seat of a hard infiltrating mass. There was considerable free fluid in the peritoneal cavity. There was no metastases in the liver. As the tumor was plainly inoperable, the tumors in the omentum and rectus muscle were removed for pathological examination, and a colostomy performed. The pathological report on the secondary tumor masses removed was meta-

static lymphosarcoma. The patient unexpectedly gained in weight and strength after leaving the hospital and resumed active life. Her anemia responded remarkably to weekly injections of reticulogen. The original tumor did not increase in size and the ascitic fluid did not noticeably accumulate. She gave one the impression that she might live for many years. Two years after the operation, however, an acute pneumonia caused her death after a week's illness.

This case resembles closely those that have been reported. In the first place the course of the disease in the aged is, as in this case, usually slow. One reported case was twelve years. In the second place the first symptom for which she was treated was increasing anemia and loss of weight and strength. In the third place the pathological process included regional metastasis in the mesenteric glands, omentum, parietal peritoneum and overlying muscles. In the fourth place, a diagnosis was first made after exploratory operation and pathological examination of the specimen.

#### SUMMARY

Both carcinoma and lymphosarcoma of the colon are described and their treatment outlined. Although much rarer than carcinoma, lymphosarcoma should be thought of especially in non-typical cases of the former. The improved prognosis of carcinoma is stressed and still greater improvement hoped for from earlier diagnosis, more thorough preoperative preparation, improved operative technic and chemotherapy. A case of lymphosarcoma of the descending colon is reported and its pathology, symptomatology and prognosis compared with those of carcinoma.

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# HEALING OF INTESTINAL ANASTOMOSIS

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THE purpose of this presentation is to describe the essentials of the process which establishes continuity of the gastrointestinal tract, following suture of wounds or anastomosis. The more common factors causing failure are also presented.

In order to study the problem, pyloric resections, gastroenterostomies and intestinal anastomoses were performed on more than one hundred dogs. Serosa to serosa approximation by suture was performed on over fifty rabbits. Varying technics were used in suturing, some specimens being made with meticulous aseptic care, others being contaminated with bowel contents. To these preparations has been added such material from the human as came to hand in the course of routine work. The latter has been sufficient to substantiate experimental results.

There are a great many problems peculiar to the individual case of gut anastomosis or repair. This investigation is limited to the following considerations: (1) Those accomplished without contamination by virulent organisms; (2) those in which unattenuated organisms may produce infected areas, and (3) those attempted in the presence of deficient blood supply.

A common method of suturing the intestinal tract has been to sew the mucosa, submucosa, muscle and the serosa in three separate layers. However, the object of all methods has been to invert the edges in order to place serosa against serosa and to hold other tissues in continuity. The description of the healing in this presentation is based upon experimental study of intestines sutured with one continuous silk or chromic catgut inverting stitch, including mucosa, mus-

cularis and serosa. Another silk stitch included serosa only. (Fig. 2, insert.)

Chromic catgut is desiccated in the process of making tissue sections and becomes bone-like in hardness. Both stitch and tissue structure about the stitch are fragmented when cut with the microtome. If the stitch is pulled out before cutting, distortion occurs. This must be recognized when such sections are studied.

## HEALING OF NON-INFECTED ANASTOMOSIS

By non-infection is meant the absence of live virulent organisms capable of growth to the extent of injuring the tissue. No anastomosis is accomplished without some bacterial flora of the intestinal tract reaching the line of anastomosis. In the stomach and small intestine these organisms are seldom capable of injuring the tissues unless gross contamination occurs. The flora of the colon more often is capable of doing this and a greater hazard of infection is always present. The effect of this on healing of the wound will be described in the next section. Here we assume its absence.

When the gut wall is inverted by suturing, a triangular chink is formed just outside of the line of anastomosis on the serosal side. The irritation produced by suture material and needle puncture causes an exudate of plastic lymph into the chink as well as between the tissue surfaces.<sup>3</sup> Within fifteen minutes fibrillar fibrin begins to form in the exudate, binding the surfaces together and making them watertight. (Fig. 1.)

A note of explanation may be necessary regarding the fundamental principles of this process. Plastic lymph is the liquid exudate from injured tissue. Sometimes it is designated as serum, but it is more than that, since fibrinogen and the other

elements of coagulation are present. In this it resembles blood plasma but that it is identical to blood plasma has not been shown.

As varying degrees of irritation may occur in injured tissue, variations in the structure of fibrin may occur so that we find fibrils uneven in diameter and some-

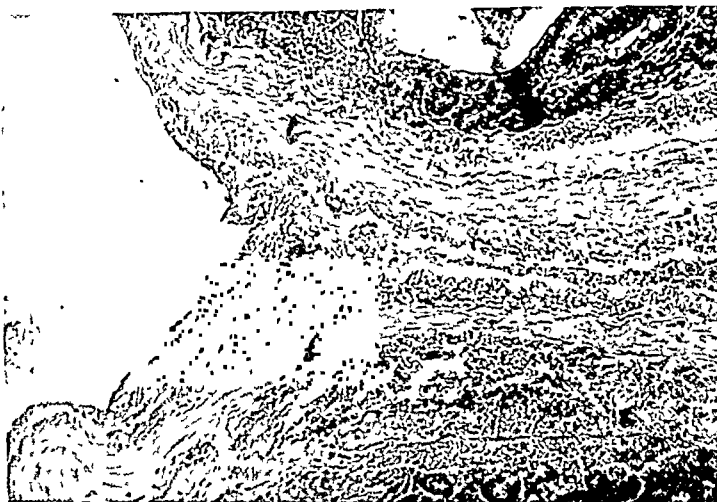


FIG. 1. Two loops of small intestines of a live rabbit sutured together with a few silk stitches. After thirty minutes the animal was killed and the specimen fixed. At *a* can be seen well developed fibrillar fibrin filling in the chink between the bowel wall at *b, b*.

Fibrillar fibrin is an arbitrary term used here to describe bundles of fibrils which develop in plastic lymph. Maximow<sup>9</sup> says about this process, "The physical factors involved in this change are the aggregation of a protein colloid of the normal plasma into threads . . . no ultimate analysis of the phenomenon has been reached."

There may be single fibrils present in the plasma of blood clot or the exudate of injured tissue but the predominant arrangement is bundles of fibrils. (Fig. 2.) The latter become minute strands of collagen recognized as connective or repair tissue.<sup>2</sup>

If the process of fibrin formation is disturbed by irritating substances, the character of the fibrils may be changed. Severe interference may cause an "aggregation of the protein colloids" into small granules and these do not become collagen. This is called granular fibrin. (Fig. 3.) Granular fibrin forming during the healing of a wound must be removed by phagocytosis and absorption before fibrillar fibrin is formed and healing completed.

times having a nodular surface giving them the appearance of a short string of beads. Unless the fibrin structure varies too greatly from the fibril type, its change to collagen fibrous tissue is not materially affected.

The fibrin bundles always stretch across the chink and between the tissue surfaces parallel with the lines of stress. A few hours later the fibrin bundles are numerous and the line of anastomosis is plugged effectively by them. Even the most rapid operator may often see this grossly when he has finished a gastroenterostomy if he examines the first stitches he placed in the serosa.

Fibrillar fibrin laid down in this fashion is invaded by mononuclear cells and these elongate along the fibrin bundles as young fibroblasts.<sup>2,5,9,11</sup> Chemical change takes place in the fibrin and by the seventh day the fibrillar fibrin becomes indistinguishable from collagenous fibrin. (Fig. 4.) Thus we have union between the serosal surfaces produced by new connective tissue.<sup>5,6</sup>

The muscle layers are united by reparative tissue in like manner. The process is sometimes disturbed by the exudate of

area greatly enlarges the volume of tissue and by its size may produce a brawny thickening of the ring amounting to



FIG. 2. Twenty-four hour specimen showing development of fibrillar fibrin, *a*, in chink between two loops of dog intestine, *b,b*, sutured together. Infiltration of monocytes and a few polymorphonuclear leucocytes has begun. At *b,b* edematous swelling of the intestinal wall aids in pushing them together, thus aiding the sealing of the anastomosis. Insert is schematic outline of technic used in suturing.

blood corpuscles but healing takes place in the same way except for the phagocytosis of debris made up of the solid elements of the blood and possible contaminating particles from the intestinal lumen.<sup>8,10</sup>

The mucosae unite by continuity. The mucosal surfaces are not separated by scar tissue and in anastomosis of two hollow viscera whose mucosae are composed of different cell structure, glands may be seen containing both types of cells at the point of union. From two to three weeks usually is required for the entire mucosal line of anastomosis to become continuous.

During the first few days following anastomosis there is hyperemia, general edema and cellular infiltration in the tissues of the sutured area. This is always quite marked in the loose tissue of the subserosa. The swelling produced by this aids in pushing the serosal surfaces into closer approximation and thus aids in closing the chink along the line of anastomosis.

The general swelling throughout this

partial occlusion of the lumen. (Figs. 2 and 4.) After a week the swelling begins to subside. In another ten days it has largely disappeared. (Fig. 5.) Gradually there is shrinkage of the repair tissue and atrophy of surplus muscle and mucosa and the ring produced by inversion of the gut wall nearly disappears.

Sutures, if of absorbable material, gradually disappear from the tissues. Permanent sutures of linen or silk seldom stay in the tissues. As atrophy occurs they are brought near the gut lumen. The irritated area they create is subject to infection and they soon penetrate the mucosa and are carried away with the intestinal contents.

#### HEALING OF INFECTED ANASTOMOSIS

Infection with virulent organisms causes granular fibrin to form—an excellent media in which organisms may function and grow. (Fig. 3.) The wound may be temporarily sealed by the granular fibrin; but before permanent union of the tissues takes place, it undergoes resolution as described above and the tissue surfaces

are freed. The wound then may be easily pulled apart and leak if the suturing and consistency of the tissue is not sufficient.

supplied with blood only through anastomosing vessels. A posterior Pólya type of anastomosis then was made to the

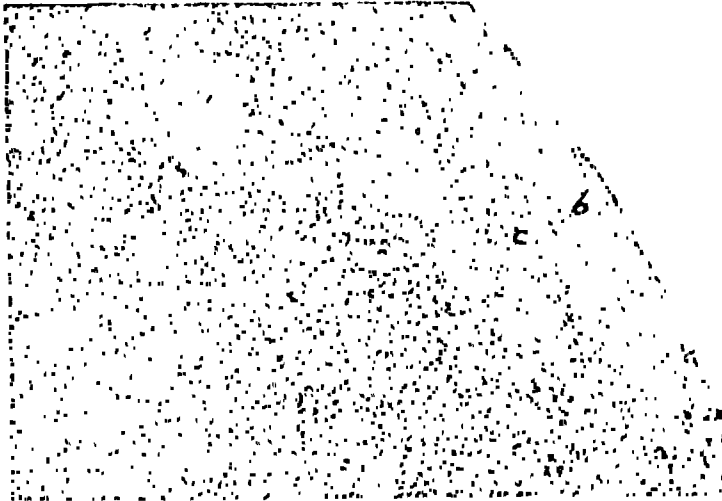


FIG. 3. Two-day specimen of line of anastomosis between two loops of dog intestine. Contamination with resulting violent irritation has caused granular fibrin to be formed at *a*. Near the surface at *b* a good grade of fibrin has developed. Between these two areas a poor grade of beaded fibrin is seen, *c*. The granular fibrin must be absorbed and replaced; *b* and *c* will develop.

The dissolution of this union occurs most often between the sixth and eighth days.

Irritation of the omentum and surrounding viscera may result in adhesions which keep the intestinal content from escaping into the free peritoneal cavity. By secondary healing the tissues may become united. Otherwise the patient succumbs to general abdominal infection.

#### ANASTOMOSIS WITH INSUFFICIENT BLOOD SUPPLY

In anastomosing viscera, the blood supply may be disturbed to such a degree that the anastomosed tissue does not contain a sufficient blood supply for its vital need. This may be caused by ligation of arteries or sutures so firmly placed as to result in ischemia. The result is, of course, gangrene of the tissues.

To demonstrate this, resections of the dogs' pylorus and part of the fundus were made, resecting the stomach at a level just above the large middle branch of the gastric artery loop on the lesser curvature. This created an area of stomach

jejunum closing the stomach near the lesser curvature, with large stitches pulled unduly tight. Ischemia of the area was the result.

Dogs operated upon in this way recovered from the operation and improved rapidly until by the fifth day their condition appeared all but normal. These animals invariably died rather suddenly between the sixth and eighth day.

Autopsy showed an area of gangrenous necrosis in the tissue where sutures were pulled too tight. This area had sloughed and gastric contents escaped into the peritoneal cavity. No adhesions were found about such areas. The stomach content had diffused throughout the abdomen. Violent peritoneal reaction was present.

Specimens of this type were studied at intervals of twenty-four hours. An exudate of plastic lymph developed in the wound following suture. Fibrillar fibrin formation began but soon underwent resolution as necrosis developed in the ischemic area. Fibrillar fibrin was never found in the presence of necrotic

tissue. No protective adhesions were developed to isolate the area of impending gangrene.

It is generally taught that suturing must be done in a manner that will make the line of anastomosis watertight. This is



FIG. 4. Seven-day specimen of healing line of anastomosis between two loops of dog intestine. At *a* is a patch of poor fibrin not entirely organized. New blood vessels, *b*, are well formed; *c, c* is the subserosa of the intestines. The monocytes have taken on the exact appearance of fibroblasts.



FIG. 5. In this eighteen-day specimen a mature type of fibrous tissue has developed at the line of anastomosis, *a*; *b, b*, is the wall of the intestine. Many small blood vessels are present, *c, c*. Edema has disappeared.

#### COMMENT

Our most tangible ally in establishing a watertight anastomosis of intestines is fibrillar fibrin. Thus its development is to be encouraged. Lack of contamination with virulent organisms and adequate blood supply favors the formation of fibrillar fibrin.

unnecessary and too vigorous attempts to accomplish it may produce localized areas of ischemia. This is particularly likely to occur where the blood supply has already been decreased. Necrosis may result. Since adhesions do not form about the gangrenous tissue, resolution of the necrotic area may result in the escape of

bowel contents into the free peritoneal cavity. The sixth to eighth postoperative day is the usual time for this to occur. Patients usually suffer intense shock at this time.

Sutures should be so placed as to fix the tissues in approximation but any small areas open between sutures are promptly closed by fibrillar fibrin. Within fifteen to thirty minutes after sutures are in place fibrin is formed and the whole line of anastomosis sealed by a plug of this fibrin. Induration and swelling in the intestinal wall soon takes place and tends to approximate the surfaces tightly.

This is of importance when considered in the light of postoperative care. Patients may be given water by mouth six hours after a gastroenterostomy or other bowel anastomosis if the wound is not contaminated with material likely to harbor virulent organisms. In four days soft diet may be given if the general condition does not contraindicate it.

There need be no fear that peristalsis will break up the formation of new connective tissue. In the series of experimental pyloric resections in which anastomosis of the stomach to the jejunum was made some animals were fed chicken bones on the third day. Only one row of chromic catgut and one of fine silk was used. No animals showed clinical evidence of leakage of intestinal contents, at the time or pathological evidence when autopsied later.

The reaction that takes place in the tissues about the anastomosis causes enough swelling to obstruct the bowel partially in some cases. This may account for some of the vomiting seen following anastomosis. If the patient can be sustained by fluids given parenterally, improvement is nearly always seen by the tenth day. The swelling has greatly subsided by this time. Swelling of the tissue should be kept in mind when making stomas of any kind in the gastrointestinal tract. Failure to do this and to recognize

its significance sometimes has caused the surgeon needlessly to reopen the abdomen a few days following operation when obstruction has developed.

#### SUMMARY AND CONCLUSIONS

1. Gastric resections, gastroenterostomies and anastomoses were done on a hundred dogs and fifty rabbits creating varying conditions of asepsis and blood supply. Studies were made of the process of healing under these conditions.

2. The line of anastomosis is made watertight by the development of fibrillar fibrin fifteen to thirty minutes after the sutures are put in if the tissue is uncontaminated by virulent organisms.

3. The presence of virulent organisms causes development of granular fibrin. When resolution of this occurs the anastomosis may be pulled apart or leak.

4. Insufficient blood supply in an area of anastomosis results in gangrene. Fibrillar fibrin is not produced in the presence of necrotic tissue. This should be stressed particularly to emphasize the importance of handling tissues delicately and of avoiding tight sutures. No adhesions form to wall off a gangrenous area. When dissolution of tissue occurs, bowel, contents escape into the peritoneal cavity.

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# AIRE-LITE\*

## A NEW PLASTIC MEDIUM OF CLINICAL IMMOBILIZATION

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THE evolution of methods of immobilization has been a notable feature of clinical surgery. Modern technics to attain this end were inaugurated by Suetin's "starched apparatus" about 1834, and culminated in the plaster-of-Paris bandage which was invented by Matthysen in 1852. Thereafter, despite Suetin's bitter opposition in favor of his own method, the superiority of the plaster bandage was soon established. Since that time surgeons have achieved such excellent results with plaster that some of its disadvantages have been largely overlooked. Among these may be mentioned its relatively heavy weight and bulk, poor penetrability to x-rays, general untidiness attending its application, wearing and removal, occasional trickiness of setting characteristics because of the qualitative differences which exist between the various grades of plaster made, poor ventilation and poor resistance to moisture and tendency to absorb moisture of all kinds, which results in irritation of the skin, discomfort to the patient and softening of the plaster cast itself. More recent improvements in the manufacture of plaster-of-Paris bandages and splints and plaster technic have overcome some of these disadvantages to a lesser or greater extent. Substitutes for plaster have appeared on the market from time to time for the same reasons but none of these has been widely accepted. It is the purpose of this preliminary report and

discussion to introduce "Aire-Lite," a new plastic medium for clinical immobilization.

Some years ago Dr. Roger Anderson conceived the principles of utilizing a plastic fabrication in the form of a dry, open-meshed and flexible bandage, which could be applied to the body, then sprayed with a volatile setting liquid to form a rigid supporting structure. He succeeded in designing, developing and applying this principle for clinical purposes. In its present form, Aire-Lite is a stockinette form of bandage made by loosely knitting a yarn composed of a mixture of cellulose acetate and a regenerated cellulose rayon. (Fig. 1.) The knitted bandage is then processed to control shrinkage, setting and drying characteristics. This processing leaves the bandage flexible and dry in which form it is applied to the body. When this bandage is in place, it is sprayed with a solvent mixture, composed of a combination of volatile liquids with acetone as one of the active ingredients, which initiates setting and drying until it becomes rigid.

The vaporization of the solvent mixture leaves the bandage unchanged in its chemical composition, but the physical characteristics of the fabrication have been altered radically. The loosely knitted loops of yarn which previously gave great flexibility to the bandage now function as rigid strut members which serve to make the supporting medium an open-meshed but strong structure. In this state this medium

\*The opinions or assertions contained herein are the private ones of the writers and are not to be construed as official, or reflecting the views of the Navy Department or the naval service at large.



is mechanically efficient, very light in weight, resistant to moisture, non-resistant to x-rays and comfortable to the patient.

used, subsequent to plaster or other methods of fixation which had been previously instituted, as an alternative (secondary

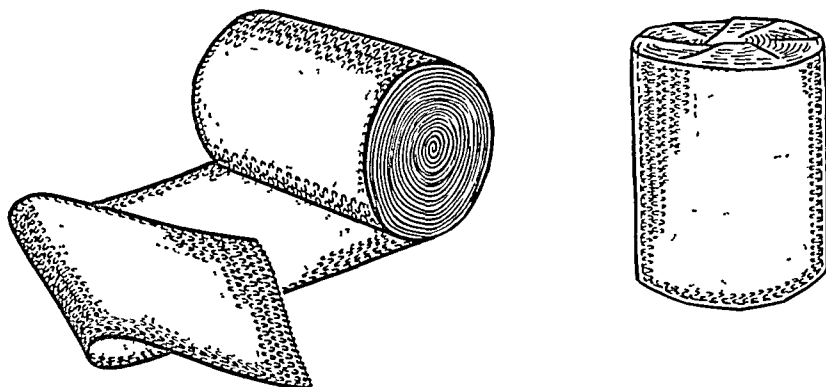


FIG 1 Sketch of an unrolled Aire-Lite bandage (left) showing its open-mesh character, and (right) as it is supplied wrapped in cellophane

We have applied Aire-Lite upon 136 patients, as indicated, in this hospital from March 27, 1944, to October 10, 1944, inclusive. One hundred twenty-two of these were in-patients and fourteen were out-patients. The vast majority of the former were of active service age, including two females, and all but two of these patients were ambulant. The out-patients were seven adult males, five adult females and a female and male child five and three years old, respectively.

*Patients for Whom Aire-Lite Was Used (Table 1):* We have classified the patients for whom Aire-Lite was utilized in this series as fractures and miscellaneous orthopedic conditions. There were eighty-six fractures of which simple and compound injuries were evenly divided. In twenty-two cases Aire-Lite was used as primary fixation at and subsequent to onset of treatment. Seventeen simple and one compound fracture thus treated were acute, four of which required manipulative reduction and fixation under anesthesia. The bones injured involved the hand in five instances, sternum in one, clavicle in one, ankle in three, shaft of the tibia and fibula in one, lower radius in three, head of the radius in one, carpal scaphoid in one and the body of the scapula in one.

In sixty-four fractures Aire-Lite was

fixation) apparatus. Twenty-two of these were simple fractures which had been present from several days with little or no callus formation to variable stages of convalescence when Aire-Lite fixation was

TABLE I  
CONDITIONS FOR WHICH AIRE-LITE WAS USED

	Primary Aire- Lite Fixation	Second- ary Aire- Lite Fixation	Total number of Cases
I. Fractures			
Simple	21	22	43
Compound	1	42	43
II Miscellaneous Ortho- pedic Conditions			
Diseases	8	4	12
Mechanical or static	18	10	28
Post-traumatic	9	1	10
Total	57	79	136

*Primary*, Aire-Lite fixation implies its initial employment from the onset of treatment as a substitute for plaster. *Secondary*, Aire-Lite fixation implies its use as an alternative apparatus, subsequent to the prior use of plaster or other forms of treatment.

employed. Ten simple fractures involved the small and irregular bones of the extremities and vertebral bodies, four the lower radius (Colles') and eight were of the long bones. Forty-two compound fractures were secondarily immobilized by Aire-Lite.

Thirty-six of these were severe. The vast majority involved the long bones, and showed variable degrees of bony dissolution

One hundred sixty-seven traditional casts were applied upon 115 patients. Eighty-seven patients wore one cast each and

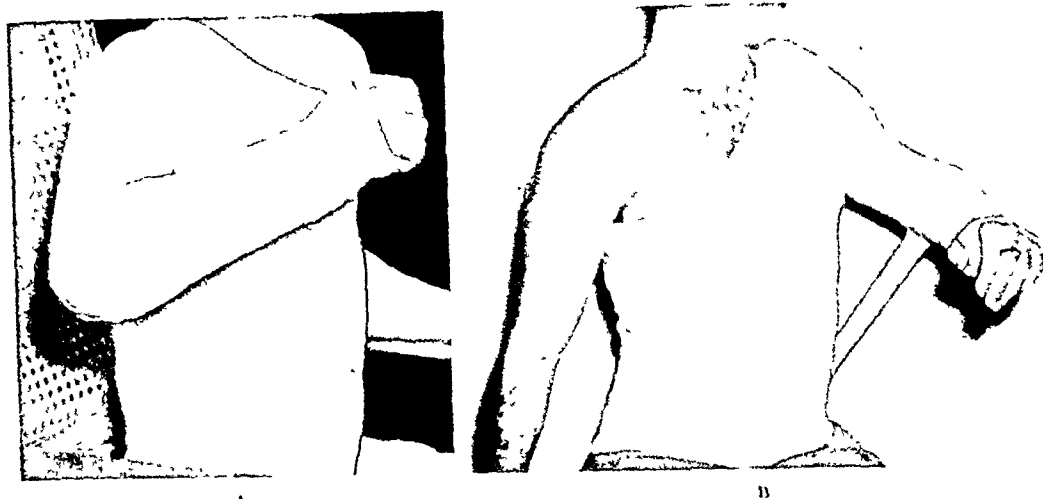


FIG. 2. Traditional types of Aire-Lite shoulder spicas. A, on a severe compound fracture of the upper humerus and scapula. Abduction of the arm was maintained intrinsically, without the incorporation of wooden struts between the elbow and body. B, on a tuberculous shoulder; three months after a combined intra- and extra-articular operative fusion had been done. A yucca wood strut has been incorporated between the elbow and body in this instance.

and osteomyelitis with little or no evidence of wound healing or bony regeneration at the time Aire-Lite fixation was begun.

There were fifty miscellaneous orthopedic conditions which included: diseased, static or mechanical situations, congenital anomalies and post-traumatic conditions of the locomotor system other than fractures, for which immobilization was desirable. The pathological lesions included hemotogenous pyogenic osteomyelitis, tuberculosis, arthritis and osteochondritis. Among the static or mechanical conditions, idiopathic low back pain and internal derangement of the knee joint were prominent. There were also a group of residual deformities which were neurogenic, arthrogenic and myositic in origin. There was one case of bilateral congenital club foot in a male child. In contrast to the group of fracture cases, the vast majority of these miscellaneous cases were primarily fixed by Aire-Lite.

*Aire-Lite Type Apparatus Applied (Table II):* Two hundred Aire-Lite casts and various forms of orthopedic apparatus of the same material were made in this series.

twenty-eight wore two or more successive casts each. Eighty-three casts were applied to the upper extremity. In fifteen instances

TABLE II  
AIRE-LITE APPARATUS APPLIED

Region of body immobilized	Type of Aire-Lite Fixation			Total number of Aire-Lite Apparatus
	Traditional Casts	Casts with Traction	Miscellaneous Apparatus	
Upper extremity:				
Forearm.....	35	9	12	56
Arm.....	41		1	42
Arm and shoulder.	9		1	10
Spine.....	22			22
Lower extremity:				
Lower leg.....	32		4	36
Leg and thigh....	25	1	5	31
Hip and lower extremity.....	3			
Total.....	167	10	23	200

the casts included the thumb and the proximal phalanges. Eight of the arm casts capped the shoulder. Nine shoulder spicas

were made (Fig. 2), of which seven were traditional in type and held the arm away from the body in varying degrees of ab-

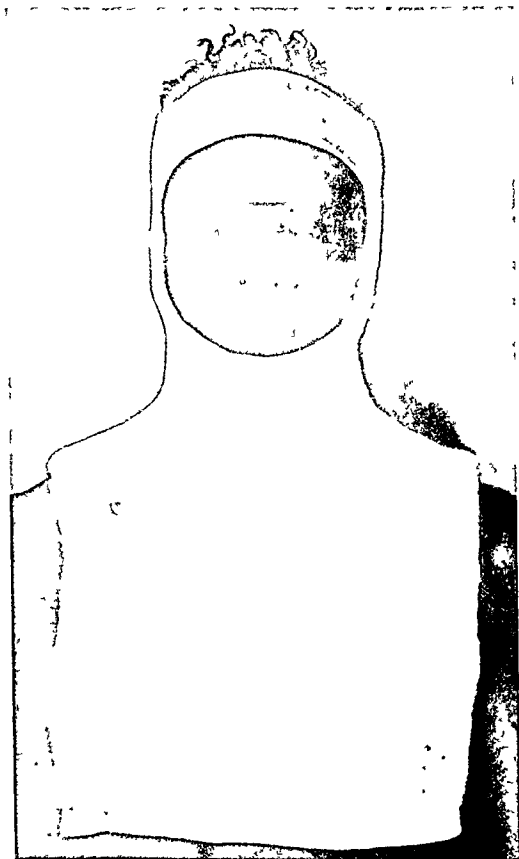


FIG. 3. Minerva type of Aire-Lite cast on a case of post-traumatic arthritis of the cervical spine. The portion of the cast covering the larynx and ears may be fenestrated or left unsprayed with the cementing fluid, as desired.

duction, while two secured the arm to the body. In one traditional shoulder spica a Cameron wire splint was incorporated in the cast to help support the arm. In the remaining six, three had yucca wood struts between the elbow and the body and three maintained abduction without additional aid. Twenty-two Aire-Lite casts supported the spine, two of which included the neck and occiput. (Minerva, Fig. 3.) In the other twenty body jackets, four went over the shoulders and sixteen ended at the axillae. In two instances the body jackets were reinforced by yucca wood splints, which were incorporated along the lumbar spine and along the sides.

Sixty casts were applied to include one or more components of the lower extremity. (Fig. 4.) Three hip spicas were made. Two of the three hip spica casts were worn by ambulatory patients. One was complete and reached to the toes; one extended to the ankle and the other to midway between the knee and ankle. Thirty-four casts were subjected to direct or indirect weight-bearing. Sixteen of these were endbearing on a rubber tipped aluminum button, secured by the plastic bandage in the usual manner. Six of twelve Aire-Lite casts which had been made for the child with congenital club foot, bore weight directly in the same way as did the previously applied plaster casts. There were twelve walking cylinders which extended from the ankle to the groin, respectively.

Ten complete plastic casts were applied to ten patients which sustained and maintained elastic or fixed traction. Nine of these casts extended from the knuckles to the elbow and had incorporated either a longitudinal or a banjo type of elastic traction. Five of these were exerted upon the skin and four on the bone by skeletal transfixion. There was one Aire-Lite cast which extended from the toes to the upper thigh into which a proximal and distal Steinmann pin through the tibia was incorporated and maintained.

Twenty-three orthopedic Aire-Lite apparatus were utilized as indicated; partly for eleven additional patients, several of whom had more than one such element, and the remainder in addition to cast treatment above. The splints made were dorsal, volar, finger, and gutter types. There were four Delbet leg splints, two of which were applied over an Unna paste boot. Elastic corrective traction was devised for wrist and elbow deformities, the former by dividing the cast at the wrist and the latter through incorporated aluminum hinges at their respective centers of rotation. (Fig. 5.) A walking cylinder hinged at the knee was utilized in one case. Two thigh buckets for provisional artificial limbs were

fashioned and secured to revised Thomas splints.

*Aire-Lite Technic.* Our basic technique

which is then unrolled on the extremity to be fixed. Such applications are effective as initial, intermediate, and finishing layers



FIG. 4. Long leg Aire-Lite cast on a simple fracture of the tibia and fibula, extending from the toes to the upper thigh, which was made by the combined stockinette, splint and roller bandage technic.

(Fig. 6) was predicated on the following inherent characteristics of the Aire-Lite bandage; reactive time lag between the bandage and the solvent as a cementing agent, slight tendency toward shrinkage and liability toward loss of its open mesh (porous) looped structure; which may be summarized as follows:

1. An unhurried attitude and technic is essential. Work calmly and deliberately; handle the bandages gently but perseveringly.

2. Do not stretch or pull the bandage into place because such tension will result in undue subsequent shrinkage when setting and drying has occurred. In order to go around prominent curves, pleat, fold or cut partially or completely at that point and begin another section properly overlapped and directed.

3. Do not mold or handle the wetted bandage as prescribed for plaster, because this will cause subsequent gelatinization and loss of porosity when the bandage has hardened. Instead, continue with smooth gentle pressure and stroking efforts toward their adherence, taking care to secure overlapping edges which do require additional cementing fluid.

The bandage itself can be applied in one or all of the following ways as desired in the individual case (Fig. 6):

1. *Stockinette.* In this form a suitable length of bandage is cut and rolled upon itself to form the typical "doughnut"

upon the extremities. Small casts may be built up entirely by successive layers applied in this manner.

2. *Splint.* In this form the bandage is utilized in convenient lengths and width. In general, splints are applied, wetted and secured one at a time. This form is particularly useful to reinforce joints and other areas which are, or may be, subjected to localized stresses. Splint technic is useful in the treatment of Colles' fractures. They are thus applied while traction and counter-traction is maintained. Splints may be arranged and affixed as follows: longitudinally, hair-pin, diagonally, crossed, staggered, or figure-of-eight. Splints are adhered or bonded best by securing one end first and then by following through in lengths of about twelve inches at a time.

3. *Roller Bandage.* This form is universally applicable to all parts of the body, and is rolled as one would a roller gauze bandage. For the average cast we recommend an equivalent of three complete thicknesses of the bandage throughout and reinforced by judiciously placed splints. Care must be taken to overlap succeeding turns of the bandage slightly more than halfway in order to preclude weaker areas containing only one layer of the material.

#### COMMENTS

A modern medium of clinical immobilization must meet and satisfy one or more

or all of several definite indications for its use in designated surgical and orthopedic cases. The greatest demand thus made



FIG. 5. A and B, front and side views of an Aire-Lite modified shoulder spica on a post-traumatic extension contracture of the left elbow, which was at about 180 degrees at the time this apparatus was applied. Fifty degrees of correction were obtained by gradual elastic (rubber tubing) bowstring force exerted through the incorporated hinges at the elbow joint. When this limit was reached, further correction to 80 degrees was accomplished by operative lengthening of the triceps tendon and posterior capsulotomy.

upon the apparatus is for absolute clinical immobilization as in the treatment of fractures. Furthermore, there are requirements in which the mechanical quality of apparatus functions indirectly or relatively as follows: to stilt or splint, sustain and traction or maintain fixed traction, and correct deformity. (Figs. 7 and 8.)

The therapeutic individualization of Aire-Lite has been summarized in Tables I and II. The preponderant use of Aire-Lite as an alternative apparatus (secondary) in the treatment of fractures was due at first to an understandable caution arising from working with a new medium, in part to the longer period of time it takes for setting and drying, and also because most of our fracture patients were evacuees from combat areas who had been treated previously by plaster or skeletal fixation. As confidence with the new plastic method and opportunity developed, a number of acute fractures were selected for clinical trial with Aire-Lite immobilization. These were successfully immobilized by this means. However, the vast majority of the simple fractures primarily thus treated by Aire-Lite did not require manipulative reduction because there was little or no displacement. These patients were not anesthetized and were thereby co-operative to a degree which compensated for the additional time and patience required by this method. Acute fractures of the small bones, Colles' fractures and fractures without displacement are, therefore, amenable to primary Aire-Lite plastic fixation. The progress of two of four fractures which were primarily treated by reduction and fixation under general anesthesia was satisfactory. Two fractures which could not be reduced by closed methods required operation. In the first of these a new plastic cast was applied postoperatively. In the second, the original cast was split dorsally, removed, and successfully reapplied after operation because of the characteristic resilience of this type of cast. (Fig. 9.) Those fractures primarily treated by Aire-Lite, which remained under our observation, healed in the normal manner.

The alternative (secondary) employment of Aire-Lite in the convalescent stages of both simple and compound fractures was both practicable and desirable in the former and was usually preferable to plaster in the latter. One of the earliest cases in our series presented a severe com-

pound fracture, with infection, sciatic nerve avulsion, and loss of bony substance, of the upper third of the femur. A similar

former under traction and pentothal sodium anesthesia. In the second case (Fig. 10), the pins which had been previously

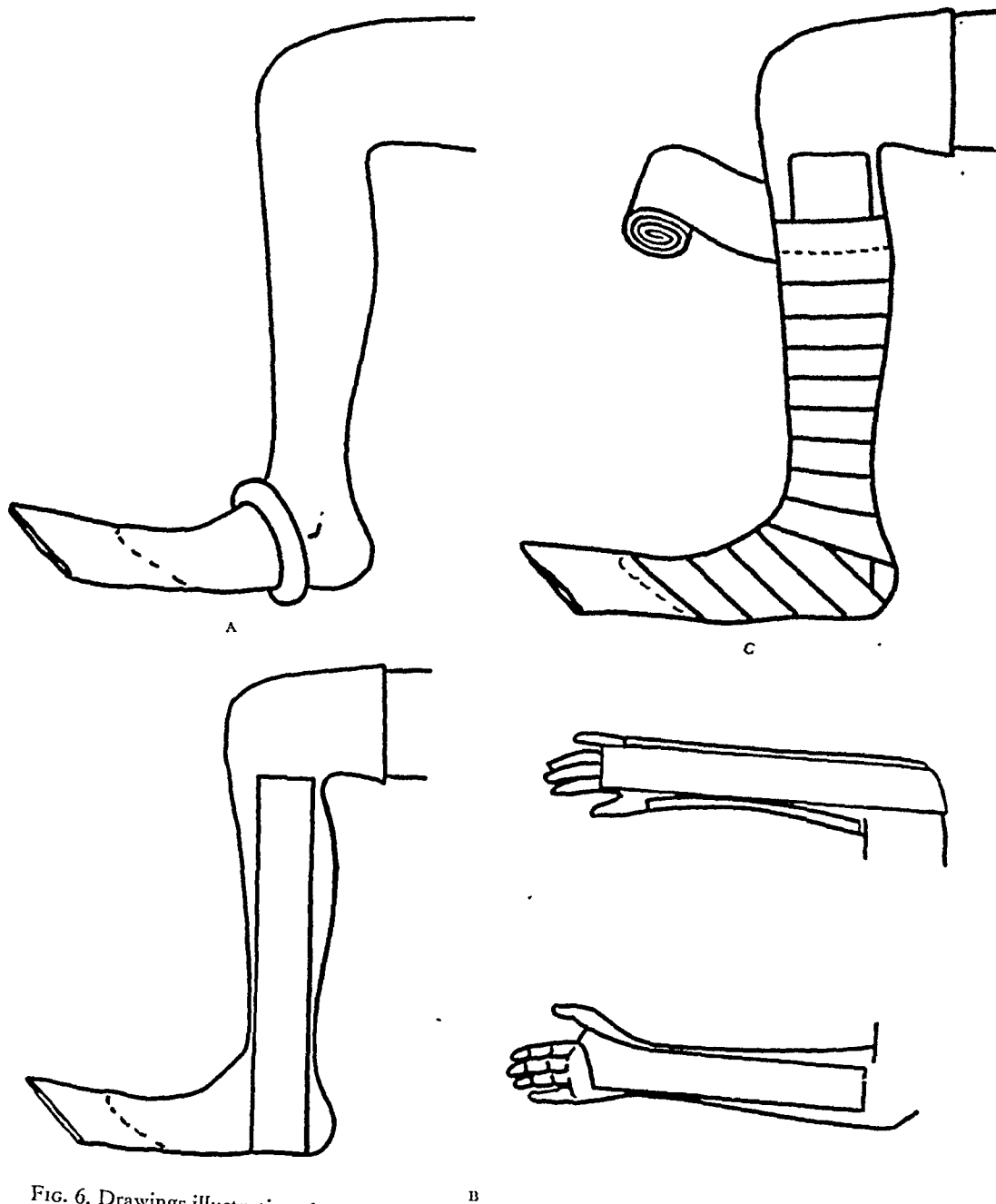


FIG. 6. Drawings illustrating the basic technic of applying Aire-Lite: (A) stockinette, (B) splint, and (C) roller bandage.

case involved the mid-tibia and fibula. Some bony regeneration was present in the femoral lesion but none in the other when the plastic was employed. A complete plastic hip spica was applied in the

fixed in plaster were subsequently incorporated in the Aire-Lite cast. A course of penicillin therapy and surgical revision was indicated in this case because of a persistent gas bacillus infection, and was

conveniently performed through a window in the plastic cast. The postoperative convalescence was excellent, and no additional

proved of great value in the vast majority of the compound fractures since they were complicated by drainage. The Orr method

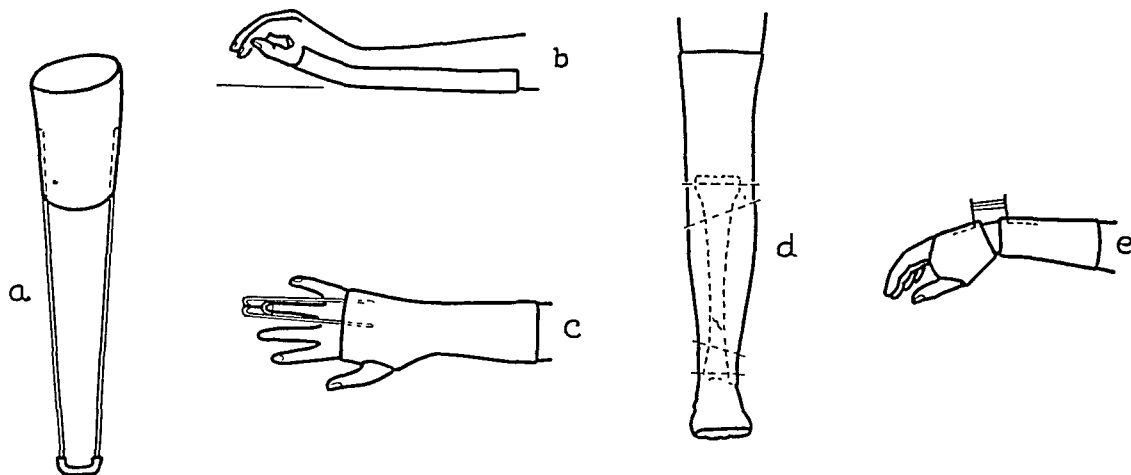


FIG. 7. Aire-Lite may be used to advantage in a number of ways in addition to the traditional forms of casts: (a) As a bucket for provisional artificial limbs; (b) as a cock-up splint, or other type of splint; (c) to sustain end traction; (d) to maintain fixed skeletal traction; and (e) to correct deformity, in this instance a flexion contracture of the wrist by dorsal elastic traction.



FIG. 8. Aire-Lite casts showing: A, on a simple fracture of the fourth metacarpal head, treated by skeletal traction; B, on a severe compound fracture of the tibia and fibula (complicated by *Bacillus Welchii*), treated by fixed skeletal traction.

definitive surgical treatment was necessary at that time.

The resistance to moisture of Aire-Lite

was used in a number of those in which surgical revisions were indicated. Plaster was applied immediately after operation

in order to save operating room time. When the plaster became soggy in a week or two it was removed and an Aire-Lite cast was

It ought to be technically feasible for surgeons in general.

More than one-half of the patients im-



FIG. 9. Two Aire-Lite casts which had been previously applied upon a case of bilateral congenital club foot, following their removal, showing the characteristic resilience of Aire-Lite. The casts sprang back and maintained their original form after removal.

then substituted. These Aire-Lite casts remained until healing was complete because they were unaffected by the drainage. Among these cases there were eight infected compound fractures which were operated upon and also given a course of intramuscular and local penicillin through a window in the Aire-Lite cast. (Fig. 11.) The almost complete absence of malodor in those instances was noteworthy, and sound healing occurred in from four to ten weeks.

A method of clinical fixation which aspires to be universally applicable must also possess certain inherent mechanical prerequisites and demonstrate additional functional requisites, none of which can be properly subordinated to the others, as follows: (1) It should be well tolerated by and acceptable to the patient. (2) It must possess both mechanical efficiency and adaptability to the body contours. (3)

mobilized by Aire-Lite in this series had previously worn plaster casts. Their spontaneous favorable reactions to Aire-Lite apparatus gave impetus to improved techniques and a more inclusive employment of this medium. The same reaction was observed among those patients who were primarily treated by this method. All patients were quick to appreciate the lightness, ventilation, and other hygienic advantages of Aire-Lite, which permitted them to bathe or shower in the normal manner.

The mechanical efficiency and anatomical adaptability of this plastic medium of support was adequate in the vast majority of our cases. There were practically no mechanical deficiencies noted because of inherent defects of the plastic material itself. Breakage occurred in eight casts because of faulty technic or uncontrollable external violence as follows: Transversely



across the anterior border of the elbow in one case, the volar part of the wrist in one, anterior border of the knee in two, tendon

feet without injuring himself or the plastic cast.

The strength of an Aire-Lite cast can

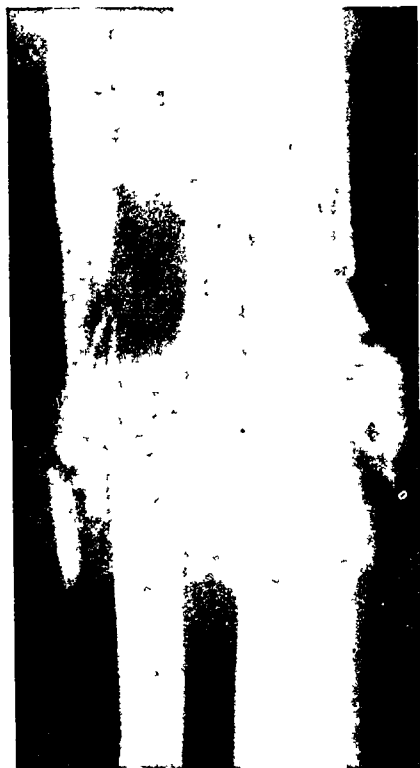


FIG. 10. X-ray of a severe compound infected fracture of the tibia and fibula taken through an Aire-Lite cast. There has been practically no resistance to the x-rays by the Aire-Lite, and the sequestrums are notable. (Same case as Fig 8B.)



FIG. 11. Showing a fenestrated Aire-Lite cast on an infected compound fracture of the tibia after sequestrectomy, by the Orr method, combined with intramuscular injections and local instillations of penicillin. Vaseline gauze protects the margins of the wound. The gauze pack has been removed to show the appearance of the wound about one week after operation. The rapidity of healing and minimal malodor in the patients thus treated were remarkable.

be essentially controlled by observing proper technic, particularly that relative to adequate thickness and bonding. Cellulose acetate, as calibrated in industry, has a high "impact strength, or resistance to breakage under sudden, hard blows. Pieces may be cemented together to make a bond as strong as the material itself. Hardness can be varied within limits, but in general, it is comparable with that of hard rubber, aluminum or hard oak wood."

A serious drawback to Aire-Lite, as was observed by us, was shrinkage. This usually occurred to a slight degree soon after it became rigid and usually reached its maximum twelve to twenty-four hours afterward. There were no untoward clinical consequences because of this shrinkage; but several Aire-Lite casts had to be removed and new ones reapplied because of painful constrictions. Shrinkage manifests itself clinically by constriction (circumferential) and creepage (longitudinal retraction). The former was especially notable about the knuckles and web of the thumb, over bony prominences in general and the female breast. This can be obviated by careful application, padding, spraying and trimming in these areas. The latter became manifest especially in body jackets and over the thighs, and here, too, special

achilles in two, posterior mid-leg in one, and at the groin in a hip spica some eight weeks after it had been applied on an ambulant patient. There were no unhappy consequences to patients as a result of these accidents. In six cases breakage occurred at a point which was composed of only one layer of the bandage. In two instances it was due to uncontrollable accidental violence. The remarkable strength of an Aire-Lite cast which had been unintentionally oversaturated with the cementing fluid was illustrated by an end-bearing fenestrated cast which extended from the toes to the upper thigh. The patient had worn this cast for ten weeks when he accidentally fell from a height of about fifteen

care must be observed to avoid such untoward results.

Plastic casts, splints, etc., can be made

Aire-Lite method in this situation. Premature attempts to reproduce the more extensive apparatus we have mentioned

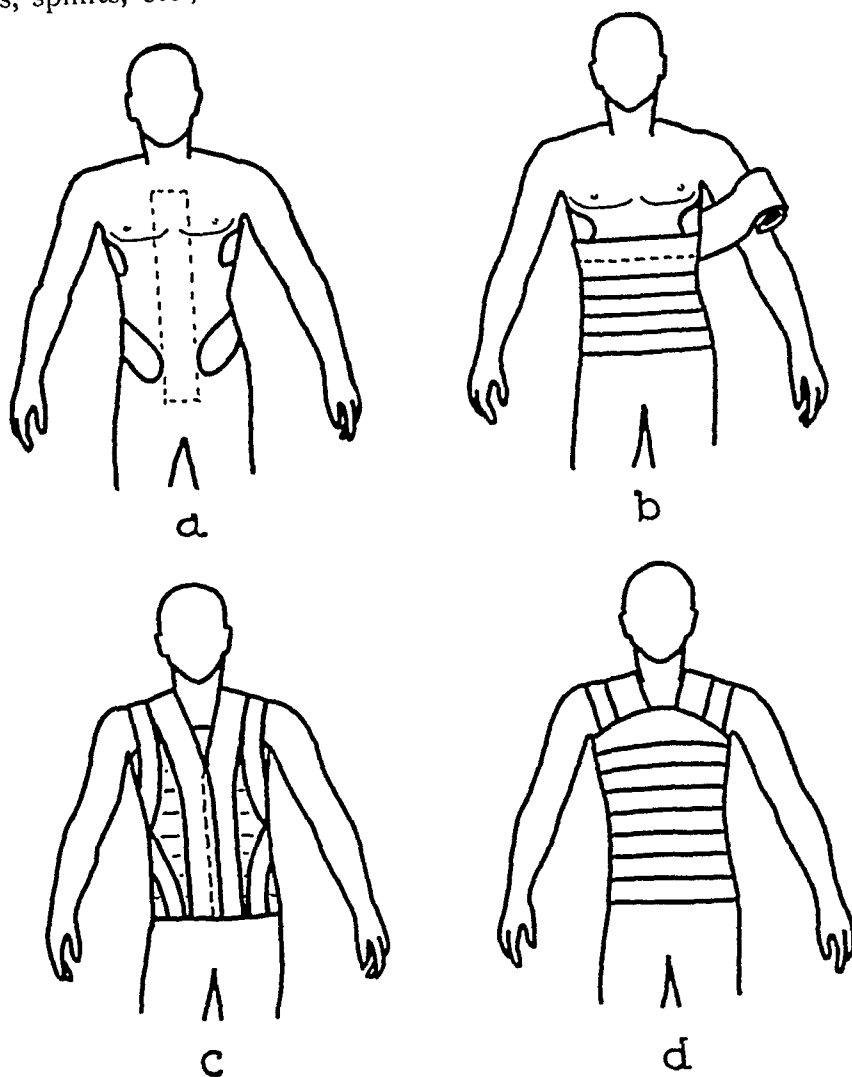


FIG. 12. Drawings showing the successive stages in applying an Aire-Lite body jacket: (a) Thin felt pads are placed as shown over a double layer of orthopedic stockinette. (The latter has been omitted in the drawing.) (b) A circular layer of Aire-Lite is then wrapped on from below upward to the axillae. (c) Reinforcing splints are run over the shoulder and cross below the axillae in all cases, whether or not the finished cast will include the shoulders. Additional plastic splints or yucca wood may be placed along the spine and at the sides if desired. (d) The cast is finished by two or more additional circular wrappings of the Aire-Lite bandage.

to conform to all parts of the body. The highly specialized dynamic function and proneness toward neurocirculatory disturbances of the hand and forearm makes exacting demands upon both surgeon and supporting medium here. The relative small size and absence of weight bearing, however, makes it easier to begin with the

should not be undertaken until one has become familiar with the technic. Body jackets, however, (Fig. 12) become increasingly attractive with practice.

Aire-Lite technic is simple but exacting. The skin is cleansed and dried in the usual manner, and is followed by one or two layers of orthopedic stockinette as desired.

Except in recumbent patients, no further padding is required, *provided one has become thoroughly proficient with the method.*

(cellulose acetate is slightly hygroscopic) and the liquid spray is accompanied by a scarcely audible fine hissing and crepitating

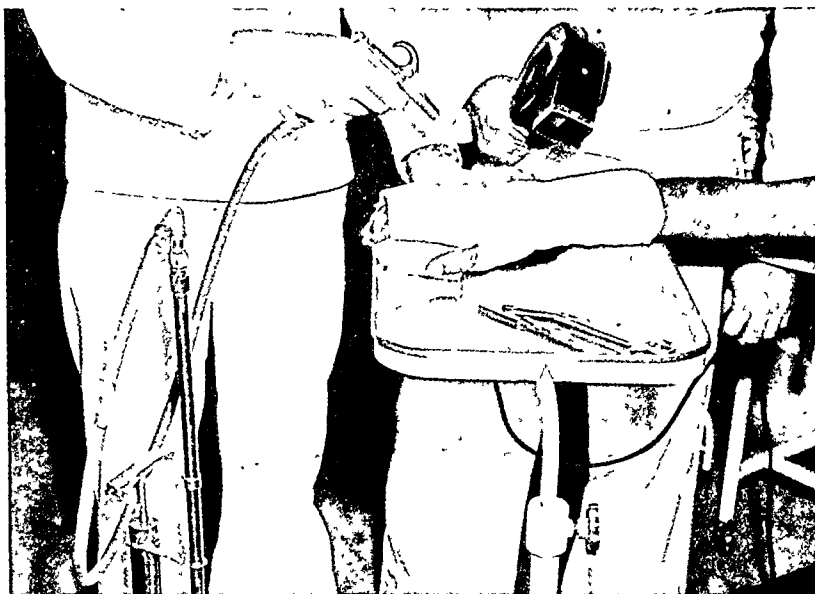


FIG. 13. Photograph showing the two pieces of auxiliary equipment which are used, *not simultaneously*, in the application of Aire-Lite apparatus: an ordinary forced draft hair dryer and the spraying apparatus. The latter consists essentially of a compact and portable unit comprising a pressure reservoir (which is not shown here), a manually operated air pump, and a pressure spray gun attached to the reservoir by means of a flexible tube. Construction is such as to provide an adequate air reservoir above the liquid which is pumped to a gauge pressure of approximately twenty-five pounds per square inch, thus providing a spray of liquid without continuous pumping.

The beginner, should observe the usual precautions along this line. Start and end the material beyond the delineated limits of support in order to anticipate creepage and to facilitate final revision for neatness and comfort. The cementing fluid is sprayed on at a right angle to each complete layer of the bandage and as needed to secure proximal and distal ends of the bandage. (Fig. 13.) This should be repeated just before applying each successive layer to facilitate adherence and bonding. Over-saturation of the yarn, especially at dependent portions, causes gumminess, subsequent gelatinization and loss of open mesh structure. Insufficient wetting results in a yielding and blistered (non-adherent) surface structure.

The setting and drying characteristics of Aire-Lite differ from plaster. The initial contact between an optimum dry bandage

sound. Immediately afterward, the mesh glistens with superficial moisture, but has not yet lost its slight starchy consistency. In a few seconds it becomes formable. This is followed by drying and setting. *The last event takes longer spontaneously than plaster.* Setting of Aire-Lite is, therefore, hastened by the use of a forced draft of hot air while the wetted bandage is being shaped immediately after it has softened; or one can complete the cast and place it within a pillow case into which the hot air is directed. *The hot air and spray should not be used simultaneously.*

The rigid state of Aire-Lite can be softened if desired by the application of pure acetone or other good solvent. Once again, when the solvent has evaporated, the rigid state is resumed. *It should be remembered in this connection that some degree of softening occurs each time the solvent has been*

*sprayed on during the application of an Aire-Lite cast. The maintenance of proper position and avoidance of hand-hold indentation and other distortions on the finished product is therefore obligatory on the surgeon.*

Aire-Lite can be applied in any ventilated room, office or hospital practice. The fumes from the evaporating cementing fluid were disagreeable to some patients when exposed to it for considerable periods. Smoking should not be permitted where this method is in progress. The plastic material burns "reluctantly." Sensitive skins of operators may become excessively dry from the effect of the cementing fluid. The use of rubber gloves or a light application of mineral oil gives adequate protection. The skin flakes left on the hands are easily removed by rinsing the hands in warm water.

#### CONCLUSIONS

"Aire-Lite," a new and effective plastic medium of clinical immobilization, has been introduced. This preliminary report is based on a series of 136 patients upon whom 200 plastic casts and miscellaneous apparatus made of the same material were employed.

Users of Aire-Lite, in its present state of development, should not expect it to replace plaster. The use of Aire-Lite fixation in acute fractures, except as mentioned in the discussion, is not wholly practicable because of the time element involved, but remains optional with the desire and discretion of the individual surgeon. Aire-Lite can be used effectively instead of plaster

(primarily) in a wide variety of orthopedic conditions as a cast, splint or other form of apparatus. The same alternative use of Aire-Lite fixation in the convalescent stages of both simple and compound fractures has also been established.

A word of caution is in order at this point: Since Aire-Lite is a synthetic plastic product, atmospheric conditions, etc., may influence its behavior in practice and interfere with uniformity of its setting and drying characteristics. One aspect of this phase of the problem is the variable tendency it has toward shrinkage and creepage which must be anticipated and guarded against by observing a proper technic and keeping the patient under observation, especially for the first twenty-four hours after a cast has been applied.

The light weight, ventilation, resistance to moisture, non-resistance to x-ray, general tidiness attending its use and acceptability to the patient gives Aire-Lite a distinct advantage over plaster.

The greatest drawback to Aire-Lite from the standpoint of the surgeon who has become accustomed to plaster is the longer period of time it takes to set and become rigid. Improved methods of fabrication and technic are needed to remedy this disadvantage.

The advantages of Aire-Lite, accruing from its inherent resistance to moisture, under naval and similar sea-going conditions, are noted. No less important is the factor of Aire-Lite's light weight from the angle of air transport.



# PROCIDENTIA

## THE CHAFFIN VAGINAL SUBTOTAL HYSTERECTOMY FOR THE CURE OF FOURTH DEGREE PROLAPSE—REVIEW OF TECHNIC AND RESULTS

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IN 1919, I published an article on a vaginal plastic procedure, which proved of value in correcting certain types of birth canal injuries, known as the Watkins-Wertheim operation. The operation, like all new methods, had to stand the test of time and skill, of the experienced as well as the inexperienced technician.

I have been performing this operation since 1912, and first reported it in 1919.<sup>1</sup> At that time it was a new procedure; its indications and its limitations had to be determined. Because these limitations were not known, too much was expected, and since the operation failed to cure every degree of prolapse, it was abandoned much too early and did not retain many enthusiastic followers.

But for those surgeons who had courage and more than average interest in vaginal reconstructive surgery, it has proved to be a very valuable constructive operation and many believe, as I do, that when indicated, as for instance in cases of cystocele of any degree, with first or second degree uterine descensus, the interposition operation is superior to every other kind of vaginal plastic procedure.

In my opinion, it is the most successful treatment of cystocele, because it is the only one that completely obliterates the opening through which the bladder protrudes. (Figs. 1 and 2.)

All types of abdominal suspension usually fail in some respects, whether they be round ligament suspension or abdominal fixation. Neither one deals with the problem of restoring the 90° angle, and restoring the sacrocervical "pull." Nor do they place a support beneath the bladder and a

floor to resist the intra-abdominal pressure. Many vaginal plastic operations have been devised for the treatment of cystocele, including the old and probably obsolete anterior colporrhaphy—an elliptical excision of anterior vaginal wall—which adds nothing to the impaired support. The anterior wall fascia is so thin that when once torn, it cannot be satisfactorily identified and returned for adequate support.<sup>2</sup>

The advancement operation, performed by loosening and displacing the bladder upward on the anterior wall of the uterus, thus suturing the vagina to anterior uterus and cervix, is easy and simple to perform. But it can be regarded as a satisfactory method only in cases of moderate cystocele.<sup>3</sup>

For the past few years, much has been written on a revised procedure of this operation, generally described by the name of "Manchester" operation. It is not mentioned under that name in many of the textbooks of gynecology. The reason may be that it is not a standardized plan but a modification of several other operations, namely, anterior colporrhaphy, bladder advancement and cervix amputation. Whether by this operation cases of cystocele can be remedied depends entirely on the ability of retrieving some semblance of the anterior vaginal wall fascia, uniting or plicating its median. Only in rare cases can that fascia be identified on both sides; therefore, what is often done is an elliptical or quadrangular resection of anterior vaginal wall and narrowing by sutures, resulting in an unfolding of the bladder and providing a support no stronger than the tensile strength of the vaginal wall, a tissue of practically unlimited elasticity.

This surgery supplies no new support and does not replace destroyed tissue with a substitute. It cannot prevent the

operation. I have completed many operations of this kind in fifteen or twenty minutes, and cannot recall ever having



FIG. 1. Sectional view of interposition operation shows the anterior (cystocele) space to be completely closed by the fundus.

uterine descensus, because it does not take into consideration the structures supporting the corpus. An attempt may be made to draw the lower edge of the broad ligaments out anteriorly to the cervix, but these tissues have little tensile strength. The fact that most, if not all, operators finish by amputating the cervix, must be regarded as an admission of not having corrected the uterine descensus. Therefore, they cut off the protruding portion in order to save embarrassment.

The bladder is the chief symptom-producing factor in this complex. And in providing support to the bladder, the Watkins-Wertheim operation is vastly superior to the Manchester procedure. But it should be emphasized that the Watkins-Wertheim operation applies only to the first or second degree descensus. It is much easier to perform than the Manchester

taken more than thirty minutes, unless the case was complicated by fibroids, chronic pelvic inflammatory disease, or other pathological condition. My own technic of the Watkins-Wertheim operation may vary slightly from that of other surgeons in that I loosen the vaginal wall and bladder well laterally, probably somewhat more so than many other operators.

But neither the Manchester nor the Watkins-Wertheim operation will remedy the fourth or fifth degree of prolapse, and they should not be attempted in such cases, the reason being that neither supplies a substitute for the sacrocervical (textbooks use the term sacro-uterine) ligaments and without this support the uterus will not remain in an axis of a degree approaching  $90^\circ$ , therefore a protruding cervix.

*Total Vaginal Hysterectomy (Not Recommended).* I do not consider the total vagi-

nal hysterectomy a constructive or scientific treatment of the prolapsed uterus. Many years ago Palmer<sup>4</sup> and others stated that

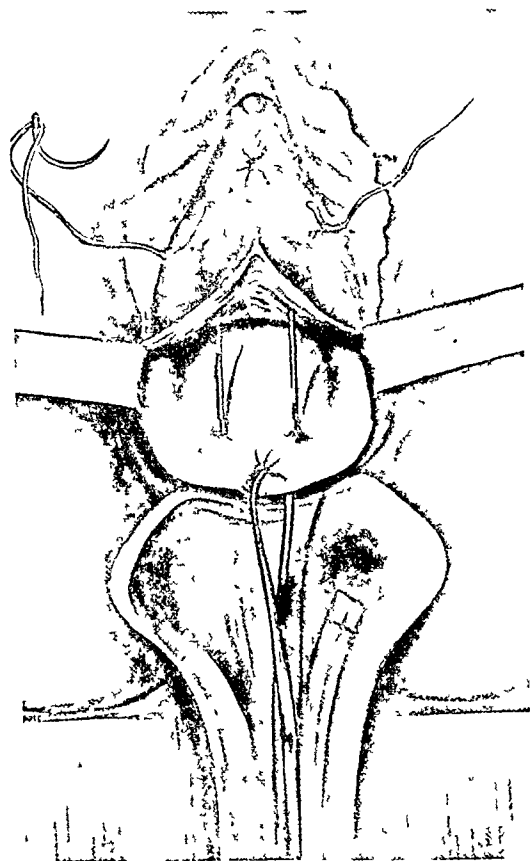


FIG. 2. Placing of the anchor sutures (should be two) well out nearly to pubic periosteum in pubovaginal fascia anchors the corpus beneath the urethra. The same with the cervix in our operation

the indications for vaginal hysterectomy were those for "removal of a diseased uterus," and not a protruding one. I concur in this statement, but I do not consider a cystic or eroded cervix to be a diseased uterus. Total hysterectomy is not indicated in such a case, as one-half to one minute Percy cautery application will remedy this minor condition. (Fig. 3.) In my own practice I have found it necessary to perform total vaginal hysterectomy only twice in the past fifteen years. In both cases the uterus was badly diseased: One operation was for a long, protruding uterus with ulceration and cellulitis of the cervix, and the other for a long, protruding uterus with beginning epithelioma of the cervix.

Total vaginal hysterectomy is technically not difficult to perform, that is the removal of the uterus itself, but as the total removal of the uterus leaves only the broad and round ligaments and overstretched thin sacrocervical ligaments with which to make repair, they must either be sutured anterior to support the bladder, permitting the possible sagging of the cul-de-sac, or if anchored posterior to this structure, the bladder may protrude. *Our operation furnishes separate support for these structures.* (Fig. 4.)

In 1937, I described an operation especially devised to remedy the fourth degree prolapse, with uterus, bladder and cul-de-sac protrusion (so-called cul-de-sac or vaginal hernia). It is now generally known as the "Chaffin Vaginal Subtotal" hysterectomy for prolapse.<sup>5</sup> It is based on sound mechanical principles, and attempts to avoid as far as possible any unnecessary alteration of the physiology or anatomy of the patient. At time of publication, only a limited number of patients had been operated upon by this method and the results were uniformly excellent. Yet, sufficient time had not elapsed to determine the possibility of recurrence. Now after approximately fifteen years have elapsed a check of something over seventy-five cases about equally divided between clinic and private, no recurrences were found. The clinic cases could not be completely followed, so there may have been recurrences there, but the percentage would be extremely low, probably not more than 1 to 2 per cent, and as that percentage seems to be much lower than some others reporting (Counseller,<sup>7</sup> Masson,<sup>8</sup> Phaneuf,<sup>9</sup> and others), I believe I am justified in again calling my readers' attention to the operation and will attempt to explain the extreme simplicity of the technic in anticipation of others adopting it as a safer, easier and more satisfactory procedure than some of those generally done.

#### MECHANICS OF PROLAPSE

The round and broad ligaments are inadequate to stand the strain of holding the

fundus in place. They are overstretched, allowing the fundus to fall backward. The pelvic floor is damaged. The levatore

abdominal pressure is now greatest in the anterior space. Last, and fortunately less frequently, come the cul-de-sac tissues,

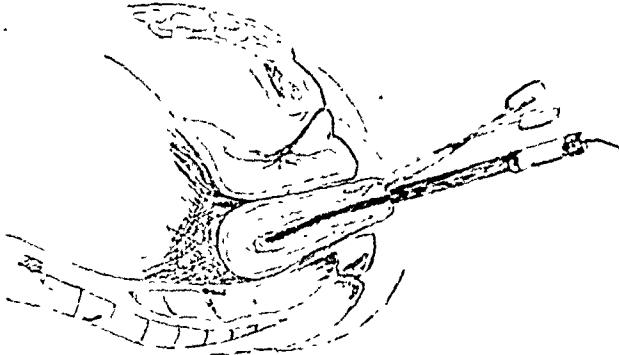


FIG. 3. Preliminary application of cautery to external os and canal to "clean up" any eroded or cystic cervix. No other cautery has sufficient heat to do this.

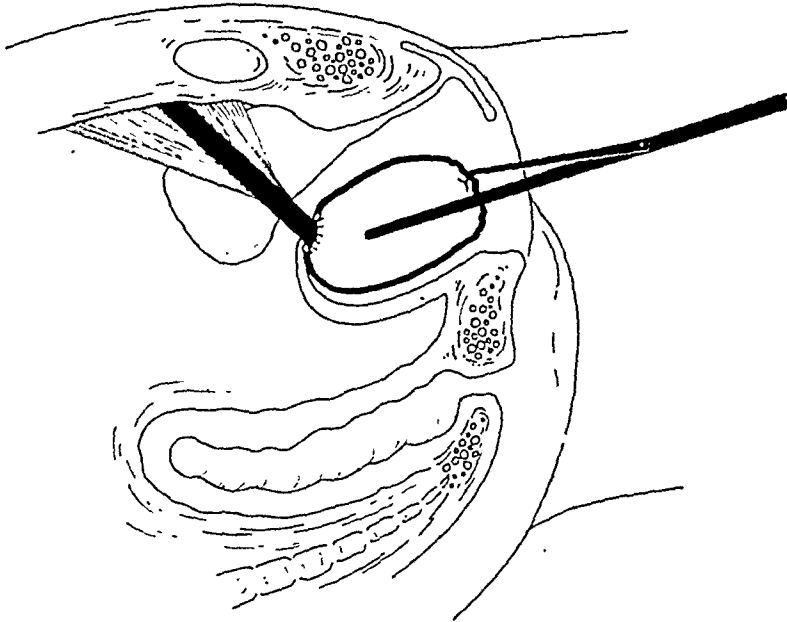


FIG. 4. Round ligaments, (sacro-cervical substitution) anchored into the posterior cervix or cul-de-sac, hold the cervix well back.

muscles are separated and the outlet recedes toward the coccyx. This causes the axis of the uterus and the axis of the vagina to become parallel and thus all the necessary factors for a uterine descensus are present.

Only the so-called "sacro-uterine ligaments" would be able to prevent such a descent; but as they are hardly more than folds of peritoneum, their strength is insufficient.

The uterus is soon protruding. With it comes the bladder, because the intra-

posterior vaginal wall and rectum, completing the picture of a fourth degree procidentia with vaginal hernia.

#### PROBLEMS IN COMPLETE PROLAPSE

1. The bladder must be supported.
2. The vaginal canal must (or should) be preserved.
3. The vaginal vault or vaginal cul-de-sac must be held up.
4. The perineum (levatores between vagina and rectum) must be adequately restored to prevent anal prolapse, and



fecal mass from bulging into vagina, and restores the normal vaginal axis.

5. It is desirable to maintain vaginal moisture from normal cervical secretion.

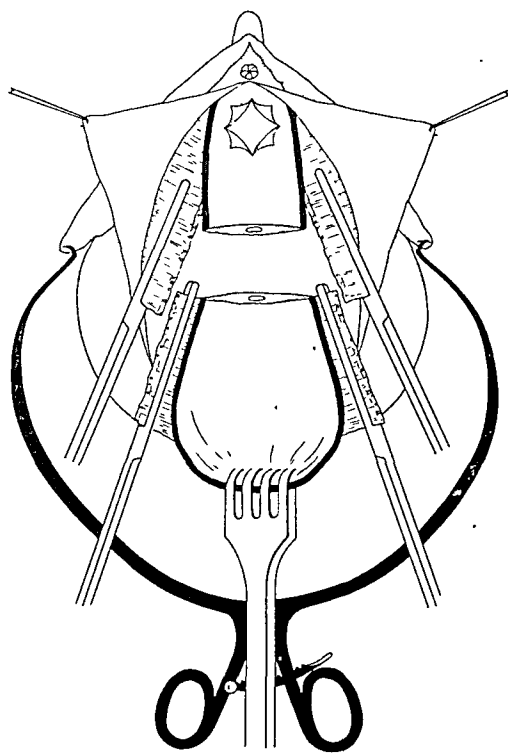


FIG. 5. Graphic illustration of the vaginal removal of the corpus to make ligaments available.

For the sake of clarity and understanding, the treatment may be divided into three factors: (1) bladder, (2) uterus, and (3) vaginal cul-de-sac.

Most of the patient's complaints are centered around the bladder, and they usually are: (1) retention, (2) protrusion, (3) frequency, and (4) leaking. The first two are the result of fascial support being removed from underneath, allowing the bladder to drop, or slide, along with the uterus or even entirely independent of the uterus.

The frequency is due to residual product. When the patient is in a sitting position, a portion of the bladder is on a lower level than the neck. Therefore, it does not completely empty, resulting in an irritable or infected bladder.

## THEORY OF LEAKING

In the bladder neck is a muscle with sphincter action. The forces applying in a sphincter are centripetal: equal from all points of the circumference toward the center, and thereby forming a circle. But in order to be efficient the perfect circle must be preserved. The bladder neck at the first perforation of the pelvic diaphragm lies near the tendinous attachment of the levatores to the pubis. A full bladder without support pulls on this one remaining fixed point, and stretches the sphincter "out of round" or "oblong." This is the reason for leaking.

I cannot recall or find in the case records a single instance of leaking that was not remedied by either the Watkins-Wertheim or the Chaffin operation for prolapse, unless there are present intravesical disease, neurological impairment or actual neck damage.<sup>10</sup>

## THE REMEDY

In discussing the technic of the "Chaffin Subtotal" operation for prolapse I will remind my readers again of the principles and accomplishment of the Watkins-Wertheim operation. It anchors the corpus to the pubovaginal fascia, completely closing the anterior space to everything but the urethra, therefore an absolute cure for cystocele. (Figs. 1 and 2.) But we have not dealt with the prolapsed cervix and cul-de-sac. The sacrocervical "pull" must be restored, but these ligaments are beyond redemption. Here we have in our operation a *substitution*. (Fig. 4.) After treating the cervix with the Percy cautery if indicated (Fig. 3), we remove the corpus (Fig. 5) through the anterior space, at or above the internal os, again applying the Percy cautery (Fig. 6) from above to the remaining cervix to destroy all endocervical mucous membrane. By removing the corpus we make the broad and round ligaments available.

We have learned that the anchoring of the fundus in the Watkins-Wertheim op-

eration will support the bladder, and just to the same degree will the suturing of the closed cervix (at site of amputation of

inverted "T" incision completes the operation. (Figs. 4 and 7.)

Occasionally, we see a patient with

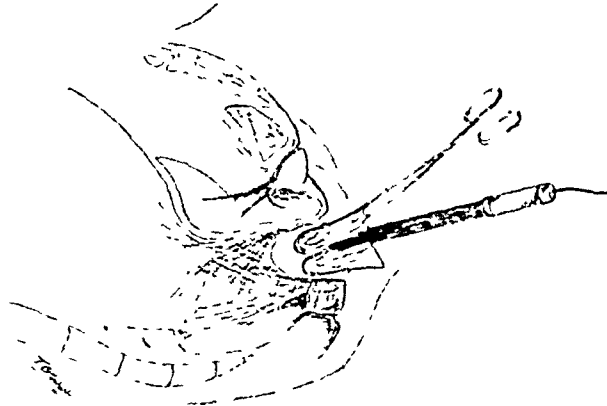


FIG. 6. Percy cautery applied to the cervix via internal os to destroy menstruating epithelium.

corpus) to the pubovaginal fascia support the bladder. (Fig. 7.) Knowing these facts we now remove the corpus (Figs. 4 and 5) to make the round ligaments available, and utilize the broad and round ligaments by suturing them into the lower posterior surface of the cervix, or in the cul-de-sac hernia cases suture them into the cul-de-sac itself. At times in exaggerated cases we bring the ends of the ligaments through the cul-de-sac permitting the ends to protrude into the vagina. These ligaments now assume the rôle of the sacrocervical ligaments, that is, pull the cervix back and up. We agree that the direction of pull is different, but the results have proved this unimportant. In cases of large redundant posterior vaginal (cul-de-sac) tissue, some of the excess may be resected by a circular or quadrangular excision, the opening closed by appropriate suturing and with the same suture, anchor the broad ligament into the closure. Also in this type of case, there may be an extra long cervix, and if so, an amputation may be made. At the time of resecting the cul-de-sac redundancy and amputating the cervix the closing sutures may include the posterior lip of the amputated cervix through the opening. The anchoring of the closed upper end of the cervix to the pubovaginal fascia with two "interposition" sutures, and closing of the

pelvic disease in addition to cystocele and prolapse. This pelvic disorder may be salpingitis, ovarian tumor, or large fibro-

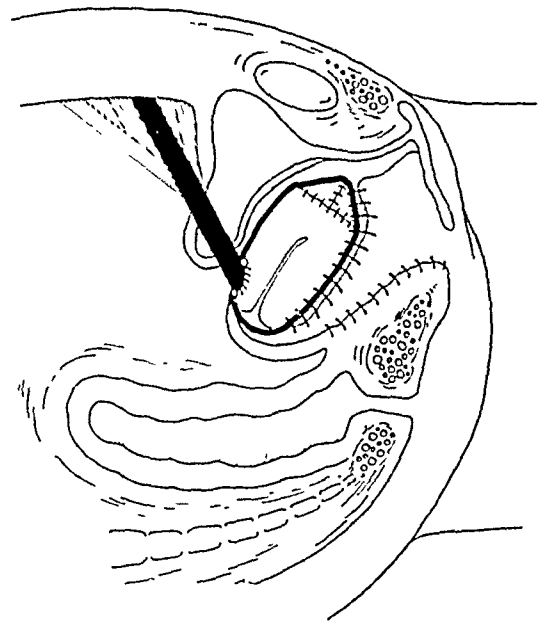


FIG. 7. Operation completed. Interposition anchor sutures holding the upper end of the cervix beneath urethra and the round ligaments holding the lower end of the cervix back, replacing the sacrocervical function.

myomas. These are the cases that if dealt with in the usual manner—a laparotomy for the pathological condition—as subtotal hysterectomy, the patient still has her cystocele and it is then a very difficult problem with which to deal. We handle

this problem by removing via the abdomen the tumor, tubes and corpus, as indicated. But from this point my readers will please

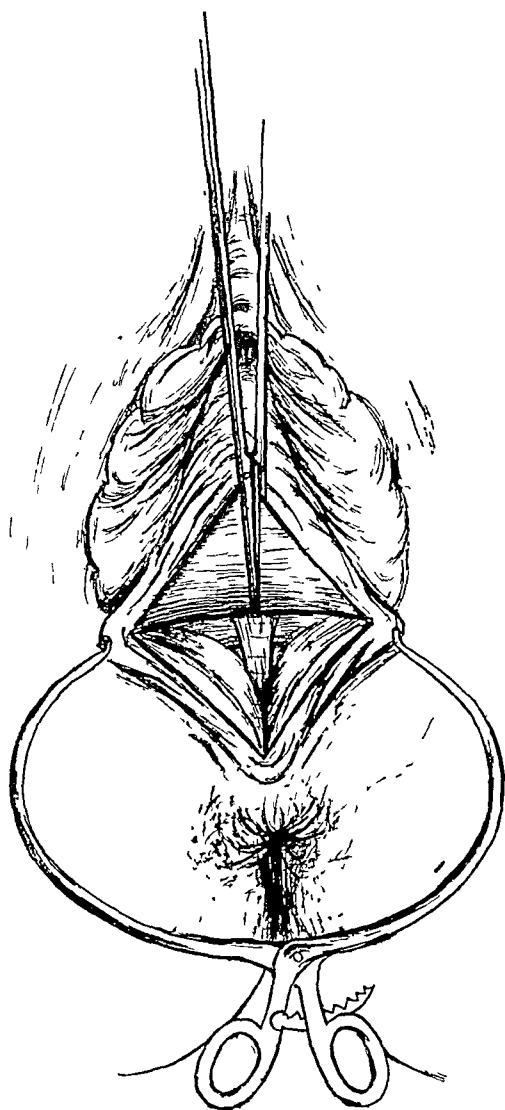


FIG. 8. Perineorrhaphy technic. Place Oschner forceps on "v" flap and it will not tear during mobilization. It is also a guide to symmetrical resection of "v" later. Levator muscles must be visualized.

note that after removing the corpus and closing the cervix the round ligaments must be sutured to the lower posterior cervix as in the vaginal operation. (Fig. 13.) Leave the cervix free and mobile, but cover with bladder flap. (Fig. 14.) Now close the abdomen and proceed with the vaginal surgery. Dissect the bladder from the cervix at the attachment of the cysto-

cervical ligament and carry the dissection up till it meets with the dissection made above. Next draw out the upper end of the closed cervix and place the "interposition" sutures just as described in the Watkins-Wertheim and the Chaffin operation. Finish with perineorrhaphy.

What we have really done is the Chaffin operation by doing half from above and half from below, made necessary because of the pelvic disorder that had to be dealt with from above.

#### THE ACCOMPLISHMENT

1. The bladder is well up in the abdomen.
2. The cervix is anchored beneath the urethra.
3. The cervix and cul-de-sac are held up by the new substitution of the broad and round ligaments for the sacro-uterine (sacro-cervical).
4. The vagina has normal length (depth).
5. The vagina has cervical secretion and the cervix is safe from cancer by double use of the Percy cautery.

Complete restoration of the levatore muscle function and reconstruction of the perineal body completes the operation. (Figs. 8, 9, 10, 11, and 12.)

In compliance with the request of many surgeons I have prepared a step-by-step description of the technic of the Chaffin operation for prolapse. Interns and residents with limited experience in vaginal surgery, have, by studying the notes, performed this operation in a creditable manner in their first attempt.

#### STEP TECHNIC FOR THE CHAFFIN OPERATION FOR THE CURE OF PROCIDENTIA

1. *Position:* Lithotomy, anus covered with towels clipped to posterior forchett. *Equipment:* Low Mayo table for instruments, two stools, surgeon and assistant. *Special Instruments:* Cat's paw (rake) retractors, Sim's retractor and tenaculum sound (tenaculum sound is most needed of all instruments), hot Percy cautery.

2. Insert a Gilpi self-retaining retractor.
3. Grasp the cervix with a single tenaculum.

few vessels will be tied in this procedure, especially in the lateral spaces. Fasten the flap by forceps to the sheet or it may be

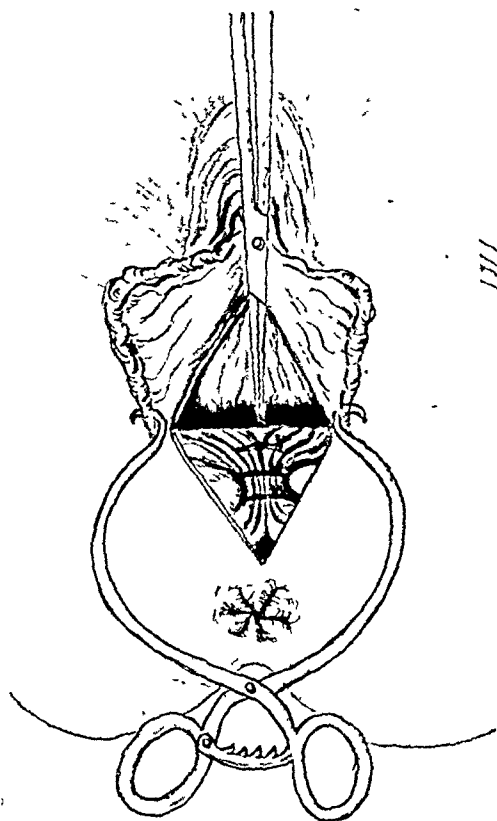


FIG. 9. Levator muscle visualized and sutured median.

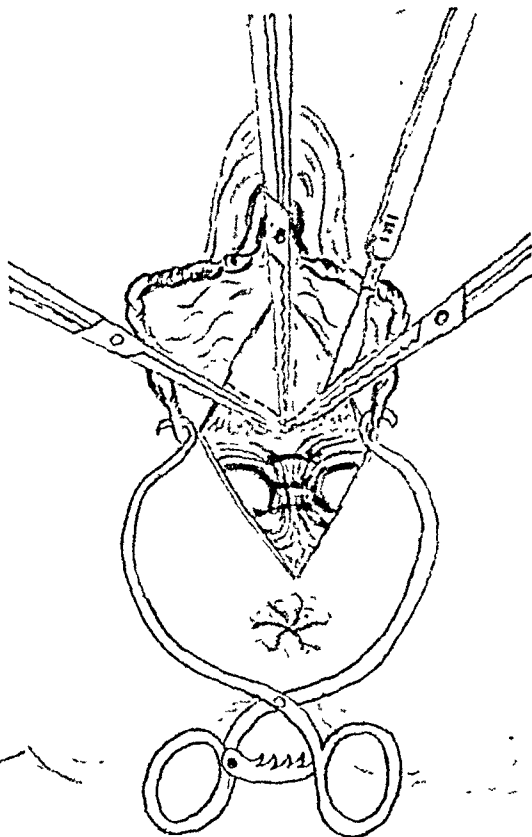


FIG. 10. Two more straight forceps outline the "v" for resection and aid in accurate approximation.

4. Note and demonstrate decensus, cystocele and condition of cervix.

5. If the cervix is cystic (not previously prepared) puncture cysts and cauterize with a red hot Percy cautery (small point), also cauterize canal if eroded or if it is an everted canal with glandular epithelium exposed. It is rarely necessary to do repair of cervix as this treatment takes only one minute or less, and usually produces a better and smoother cervix than cutting.

6. Insert the tenaculum sound and put the uterus down for assistant to hold firmly at all times. (A weighted speculum is not used.)

7. Make an inverted L (T) incision well up to the urethra.

8. Dissect back the vaginal flap well into the region of the broad ligament laterally and well up to the peri-urethra tissues. A

held laterally by an "upstairs" (not sitting) or second assistant.

9. Pick up the bladder and incise cysto-cervical ligament to begin the upward dissection of bladder. (This "start" is critical for the inexperienced and he may be made to feel safer if he views the tissues laterally in which position light will be transmitted between bladder and cervix.)

10. Carry the bladder dissection well up until the peritoneal reflection is seen. (Note the transparency of the peritoneum and that it slides on the uterus.)

11. Insert a Sim's retractor to pull the bladder well up and back.

12. Pick up the peritoneum and incise with scissors.

13. Replace the Sim's retractor in the peritoneal opening.

14. Examine the adnexa and size of the uterus with a clean finger.

15. Grasp corpus with a single tenaculum by a good deep "bite." Trauma is not

passing through the pubovaginal fascia laterally well back (sometimes close to the pubic ramii to get a strong fixed "bite"), and at a level just below the urethra. These

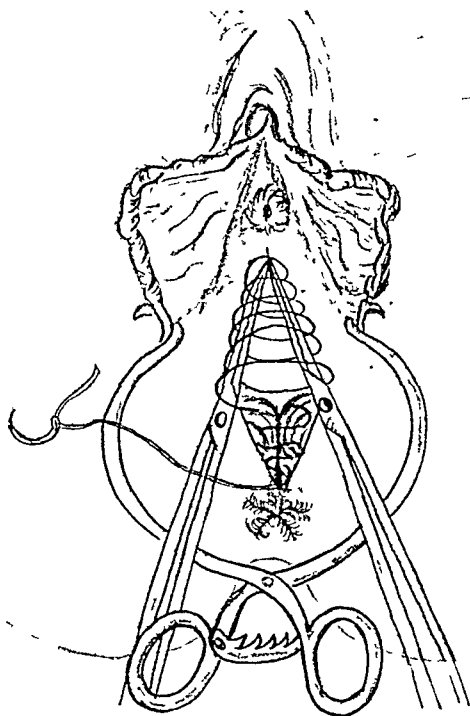


FIG. 11. Flap has been removed and sutures pass over forceps before their removal; the skin is closed with a sub-cuticular application of the same suture.

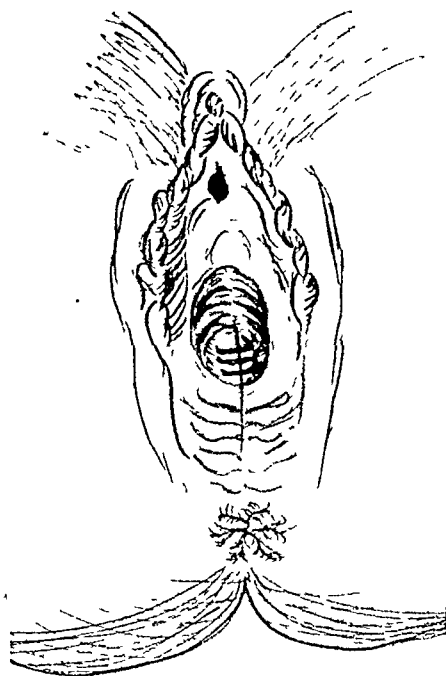


FIG. 12. The perineorrhaphy is completed. Note: In these perineorrhaphy drawings the anterior wall has been entirely omitted by the artist.

important as the fundus is to be removed if the patient has a prolapsed uterus or a fibroid; but when only an interposition is to be done to cure the cystocele and a first and second decent, the cat's paw retractor may be used to deliver the small senile corpus without trauma.

16. Remove the tenaculum sound and forceps from the vaginal flap (8).

17. Remove the Sim's retractor and grasp the cervix with a single tenaculum or Allis clamp and "push in" as the corpus is pulled out.

ALL THE ABOVE STEP-BY-STEP TECHNIC IS THE SAME FOR THE INTERPOSITION AND CHAFFIN PROLAPSE OPERATIONS BUT VARY FROM THIS POINT:

A. The interposition operation is completed by inserting two suspension sutures

sutures pass through the "high point" of the fundus.

B. Do not tie these suspension sutures but leave sutures loose at this stage.

C. Push fundus back in the abdomen and pull out the cervix.

D. Repair inverted T incision and trim off vaginal wall if indicated. All transverse sutures of the vaginal wall are to include the anterior wall of the cervix. Leave flap unsutured just below urethra.

E. Insert finger into this opening to push the bladder back and tie suspension sutures. Finish the vaginal closure, i.e., unsutured flaps.

F. Perineorrhaphy.

#### CHAFFIN PROCIDENTIA TECHNIC

18. Pull down the corpus (15) firmly and clamp the broad and round ligaments *en*

masse with straight Oschner forceps, three on each side, close together.

19. Cut between one and two (leave two on ligaments).

vaginal hernia is present, insert ends of ligaments in incised opening, or if short (moderate prolapse) suture firmly to denuded area.

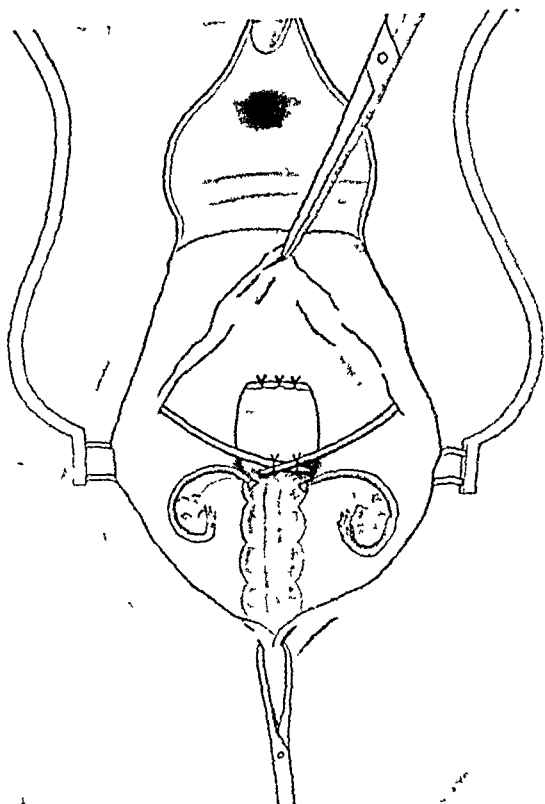


FIG. 13. Abdominal subtotal hysterectomy. The bladder flap held up, cervix has been closed and ligaments anchored low on posterior surface of cervix; about the level of the sacrocervical ligaments. A transverse incision should be made to bury these ligaments at this point. Omit the tubes.

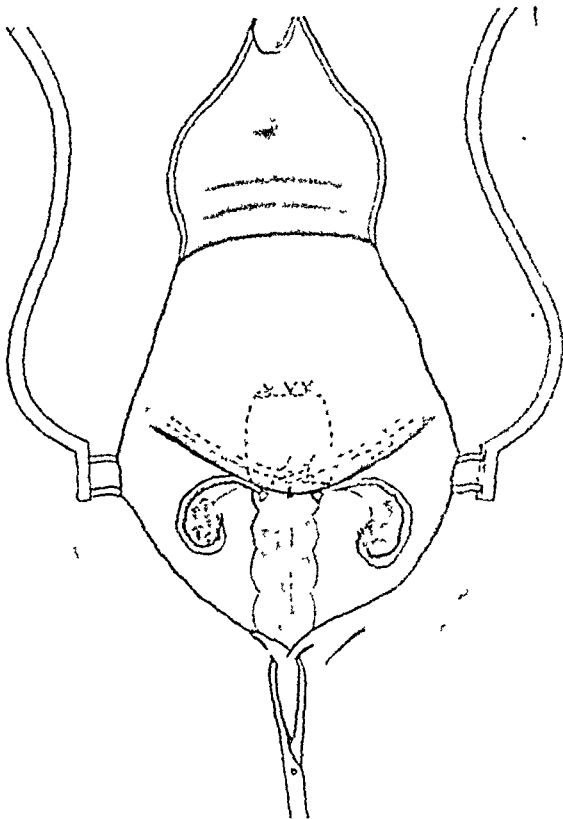


FIG. 14. Same as Figure 13, showing the cervix and ligament "anchor site" covered by the bladder flap. The cervix is free under bladder, ready to be approached from vagina, anterior colpotomy and placing of "interposition" sutures.

20. Clamp the uterine artery at the site of the amputation and remove the fundus.

21. Insert a Percy cautery in the cervical canal to destroy all endocervical mucous membrane.

22. Insert a tenaculum sound in the cervix from above (cut end) and make traction down (assistant holds).

23. Tie ligaments and vessels so that ligaments are mobilized away from the cervix by forcibly "tearing" laterally.

24. The lower end of the cervix covered by the posterior vaginal wall (cul-de-sac tissues) will now be presenting in the field.

25. Denude or incise through into the vagina; if the ligaments are long and a

26. Close the cut (amputated and cauterized) end of the cervix and pass suspension sutures through the pubovaginal fascia and cervix at the site of closure (A).

27. Follow with A, B, C, D and E.

28. Perineorrhaphy is performed by high levatore repair. Catheterize the patient and insert a vaginal pack for twelve to twenty-four hours.

29. Postoperatively, do not allow the bladder to become over-filled and tell the patient and all nurses that a four, six and eight-hour catheterization is probably necessary for several days. Catheterize for residual urine after the patient voids. I like intermittent catheterizations better than

the retention catheter as it makes for less frequency after recovery (optional).

#### SUMMARY

We have reviewed our results with the "Chaffin vaginal subtotal" operation for prolapse. An analysis appears to disclose that results are superior to any other type of surgery. This technic is again discussed. The explanation and reason are given for the better results. The operation is simple and more easily performed than other vaginal plastic procedures. It is applicable to all ages as it restores and maintains the normal vagina.

#### CONCLUSIONS

If my readers will carefully study the principles and mechanical factors of prolapse which I have presented, and analyze the operational technic applied, they will arrive at a better understanding of the reasons for which some other procedures failed to succeed. They will appreciate the simplicity of this operation for the treatment of fourth degree prolapse, which

proved to be more effective than other methods.

We believe that if this operation is done more often we will not see so large a number of cases of recurrent prolapse of the bladder and vaginal vault, with shorter, dry and excoriated vaginal canals.

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# FAILURES IN MAMMAPLASTIC SURGERY

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**M**ANY mistakes in technic and errors of esthetic judgment are made occasionally by surgeons who undertake plastic reconstruction of the female breast. The resultant failures, complications and sequelae disturb and discourage both patient and surgeon.

An analysis of some of the surgical acts of omission and commission will, it is hoped, tend to eliminate the usual untoward results and complications. And in truth, a satisfactory result is one that meets with the purposed esthetic pattern which wholly satisfies the conscientious surgeon, but not always, regrettably enough, the occasionally neurotic patient who requests that the operation be scarless.

Many technical failures are, of course, due—as in other surgical and non-surgical spheres—purely to inexperience. Nothing further need be said on this score. It is rather the avoidable errors of the experienced surgeon in the fields of mammaplastic procedures that require consideration.

Reconstruction of the pendulous hypertrophic, or atrophic breast, is unquestionably a major operation. It is carried out under general anesthesia and under the usual aseptic and antiseptic precautions.

The anatomic structure of the breast, and in particular the blood supply thereof, is of basic surgical importance. It should be recalled that the mammary glands derive their blood supply from the following sources: (1) The internal mammary artery sends five perforating branches to the anterior surface; (2) the external mammary artery, with its external mammary branches, supplies the external and lower part of the gland; (3) the superior thoracic artery sometimes stems directly from the axillary artery; (4) the internal

branch of the thoracic-acromio artery; (5) the lateral branches of the second, third and fourth intercostal arteries which supply the posterior aspect of the gland and form an interlacing network for the lobes and lobules; and (6) an artery for the nipple branches directly from the fourth intercostal artery.

A thorough knowledge of the histologic structure of the breast is essential in all surgery of the organ. It must be ever kept in mind that there is a great variation of structure observed even in the normal mammary gland—a degree of variation, according to C. Creighton, “from time to time and from individual to individual which is without parallel in any other mammalian body.”

It is axiomatic that the success or failure of any reconstructive or reparative surgical technic depends upon the maintenance of an adequate blood supply. If this is interfered with seriously, the result is put in jeopardy and is sometimes disastrous.

Nearly all failures in mammaplastic surgery are due to post-surgical complications which are mainly consequent upon: (1) Hemorrhage, (2) liquefaction of fatty tissue, (3) infection, sloughing and gangrene of skin, breast tissue, or both areola and nipple.

Secondary hemorrhage sometimes occurs in all instances, and in all areas, where incisions are made. It is of utmost importance to ligate even the smallest “bleeder” carefully and at any stage of the operation the exposed area must be thoroughly examined for the source of further oozing. Bleeding ordinarily occurs lateral to the serratus muscle and along the upper margin of the mammary gland (branches of the internal mammary artery.)



Bleeding is definitely increased during the premenstrual day and during menstruation. The optimal time for mamma-

Secondary hemorrhage, with clot formation, is often responsible for the ruin of an otherwise successful mammaplasty. The

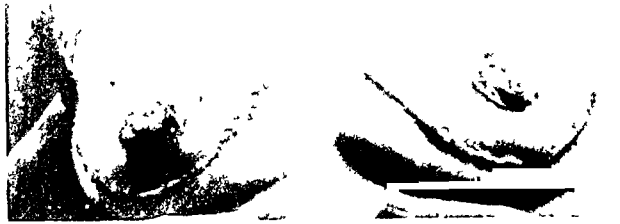


FIG. 1. Asymmetric placement of nipples with keloidal scars after buttonhole technic.



FIG. 2. Unsuitable case for mammaplasty.

plastic surgery is, therefore, the second following week. All other causes which may increase bleeding during the operation must be anticipated and adequately met. It is likewise unwise to operate shortly after pregnancy, that is, before complete uterine involution has taken place.

normal blood circulation to contiguous and circumjacent tissues is interfered with. An infarct of variable dimensions frequently results, with eventual necrosis and sloughing. A blood clot along the line of internal catgut sutures, for example, will loosen the strands and transform

them into foreign bodies. These produce local changes, impairment of healing and an unsatisfactory result.

Regulation of blood pressure before operation is absolutely essential as well as an appraisal of the patient's general condition and her metabolic rate.

The most common complication in mammoplasty is fatty tissue liquefaction. This may not be manifest for weeks or even months. In most diffuse, hypertrophic breasts the glandular tissue has been relatively lost and substituted by degenerate fatty tissue. This variety tends to break or destroy the surrounding cell membranes and to liquefy its contents. The change is similar in some respects, to that which occurs in the formation of an abscess. Inflammatory reaction sets in with the usual temperature rise, which is sometimes high and accompanied by chills. This sterile abscess of liquefied tissue must be opened and drained under the most thorough aseptic precautions. The symptoms then ordinarily disappear. It is extremely doubtful if these post-surgical abscesses can always be prevented. It is imperative during the operation to maintain proper temperature by continuous application of body-temperature compresses to the surgical area. The time element is an important factor. Exposure of breast tissue should be of minimum duration as is consistent with a speedy technic.

It is of prime importance that the surgeon be familiar with the aforementioned complication and not to mistake it for an actual infection. The patient, too, should have a clear understanding of the nature of the sterile abscess.

When a post-surgical infection occurs, it must be treated like any other infection of a similar nature in general surgery. The use of one of the sulfonamide group of drugs will be found effective.

The surgeon is often confronted with the problem of tissue necrosis which may be due either to inadequate, or destroyed, arterial blood supply of main

branches, or to venous congestion consequent upon secondary hemorrhage or even mere oozing. No part of the mammary



FIG. 3. Superficial necrosis of lower part of areola two weeks after mammoplasty.

gland after surgery is exempt from such a complication. In some instances only a small area of skin is involved. Sloughing, as a result, occurs along suture lines. (Fig. 1.) The skin appears whitish. Soon a bluish, necrotic demarcation takes place and the necrotic skin can then be excised. Healing takes place in the normal manner. Sloughing of skin only, however, is extremely rare. In most instances the obstruction of blood circulation starts somewhere within the breast tissue. The process of demarcation takes a much longer time and usually includes the integument. When sloughing of breast tissue occurs only below the external suture lines, the skin proper may not be involved. Sloughing ordinarily occurs in the upper, lateral quadrant of the breast along the edges of the underlying serratus muscle. Radial sloughing is the most frequent. Six to eight days after the operation this area appears grayish-white, cold and anesthetic. The patient complains of a sense of great weight in the breast. The necrosis

takes its usual course and it is advisable to accelerate the demarcation by infra-red radiations and application of balsam of Peru along the delineating edges.

lobular ducts. This is painless but the patient must be frankly informed of the serious nature of the complication.

If the bluish discoloration of nipple



FIG. 4. Hypertrophied breasts showing extensive varicosities.

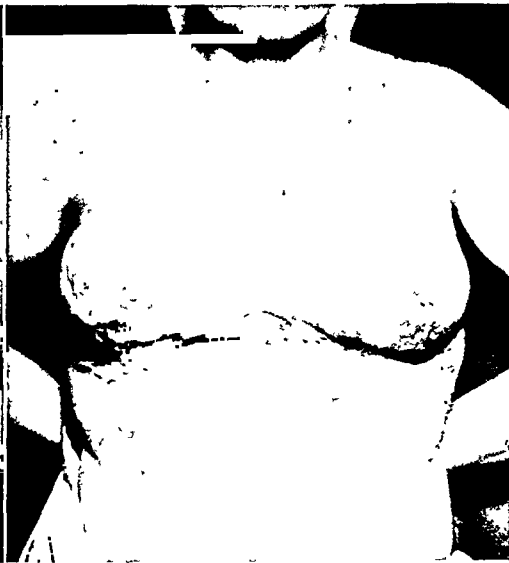


FIG. 5. Same patient as in Figure 4 showing beginning, complete necrosis of right, and incomplete necrosis of left nipple.

The isolated zone of tissue is excised under aseptic conditions. The shape of the breast after this excision can be maintained by tight strapping with sterile adhesive tape, which approximates the areas between healthy tissue and healthy skin. Sloughing of areola and nipple is the most serious complication in mammoplasty surgery and certainly the nightmare of every surgeon engaged in that field. The first sign is nearly always observed at the first dressing, which is usually changed within twenty-four hours after the operation. Nipple and areola, which normally are pinkish and brownish, appear dark blue or purplish and sometimes almost black. This is the great danger signal of beginning necrosis of both areas. If, at this stage, proper medical treatment is not administered or proves ineffective, surgeon and patient will go through many disturbing weeks or months. The destruction usually includes a circular wedge of underlying breast tissue. A crater-like necrosis finally appears involving the confluent lobar and

and areola appears at the first dressing, the surgeon can utilize one or more of three restorative measures as regards the blood circulation. These are: (1) Removal of interrupted sutures and manual expulsion of blood clots which may be responsible for the decreased blood supply; (2) increase of arterial blood supply by artificial hyperemia produced with infra-red radiation, or application of frequently renewed alcohol sponges, or hot poultices, and (3) application of leeches (highly effective) directly in and around the discolored area. (Leeches, incidentally, inject the chemical substance Hirudine into the bloodstream which prevents coagulation for about eight hours. To be beneficial they must be applied within twenty-four hours after the operation.) Sterile compresses to absorb the slowly flowing blood should be used continuously.

The changes brought about are sometimes truly miraculous. Normal color appears within areola and nipple and the complication clears up. The best systemic

indication of this is a lowering of the temperature curve.

Where plastic reconstruction requires

In some instances, an apparent necrosis solely of the nipple is evident at the first change of dressing. Application of one



FIG. 6. Almost total loss of both nipples after mammaplasty (buttonhole technic).



FIG. 7. Extensive sloughing of right breast, fatty abscess of left breast with a resultant misplacement of both nipples.

resection of a small segment of breast tissue only, the temperature following the operation, in the absence of complications, remains almost normal. In diffusely hypertrophied mamma ("heavy breasts"), which requires extensive resection consisting mostly of fatty, degenerated tissue, a rise of temperature up to  $102^{\circ}\text{F}$ . after the operation is often noted. This is due to resorption of small fatty or necrotic particles and exceedingly minute blood clots. If the temperature elevation is concurrent with a bluish discoloration of areola and nipple, observed at the first dressing, the success of the application of the aforementioned remedial measures will be shown by a restoration of the normal coloration to the part. An elevation of temperature to  $104^{\circ}\text{F}$ . or more is indicative of progressive necrosis of areola and nipple.

While sloughing of an area of breast skin reduces the size of the gland it does not interfere subsequently with function. Necrosis of areola and nipple, however, leaves the gland functionless.

leech to the affected area may save the blood circulation of the nipple. If this fails, the necrosis only involves the epidermis of the nipple and does not interfere with the function of the mammary gland.

Sometimes discoloration and signs of beginning necrosis appear only along the suture line around the areola, while the nipple and center of the areola are of normal color. Here, immediate removal of sutures is indicated as well as infra-red radiation.

Progressive gangrene of the mammary gland is a rare complication. I have seen only one case and know of only two others. In the three, the complication took the same course. Primary healing of incisions took place at first; then suddenly, on the tenth or eleventh post-surgical day, somewhere along the surface, a "dime-sized" bluish gray spot appeared. The patient felt sick and nauseated. The temperature was only slightly elevated. Within two or three days the skin broke and discharged a thick, fetid pus containing leucocytes,

cell fragments and low-grade bacteria. Within a few days a similar change took place an inch, or half an inch apart, from

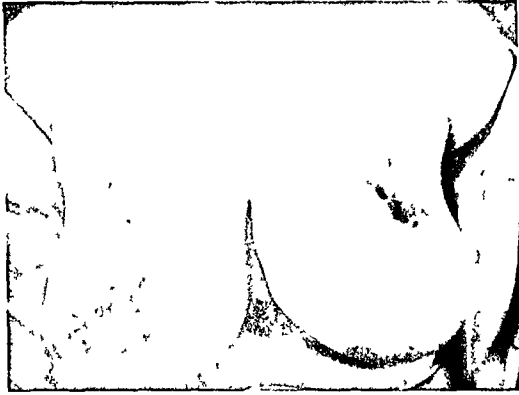


FIG 8. Asymmetric implantation of nipples with subsequent sloughing.

the primary area. Soon grayish spots were noted within and outside of the entire surgical field toward the axilla,

However, both nipples remained intact with a strand of fibrous tissue extending to the lower aspect of the mammary gland area. For repair the entire involved skin was excised and an abdominal skin graft was attached to the remaining areola and nipple.

In one case, on the sixth post-surgical day, the entire upper half of the left breast appeared bluish-white. It was clammy and apparently revealed a beginning necrosis. After application of tyrode modification over the involved area the process regressed to normal in twenty-four hours; the skin discoloration disappeared and healing took a normal course. Another patient's breast apparently healed without complications. She had been discharged but returned during the seventh post-surgical week. The outer half of the right



FIG. 9 Striking failure in mammaplasty—"pancake" effect.

clavicle, sternum and abdomen. In the case I saw in consultation, the entire breast, including the skin, sloughed off over a period of six or seven months.

breast showed bluish and purplish discoloration, swelling and inflammation. In the middle of the breast (toward the mid-axillary line) a liquefactive focus appeared

and indicated incision and drainage. Instead I applied tyrode modification over the entire area. After 24 hours the swelling was greatly reduced, the area of liquefaction was treated daily and in two weeks normal circulation was restored and a gratifying result obtained.

#### CONCLUSIONS

The early recognition by the surgeon of complications and prompt attention are helpful in eliminating them and obtaining gratifying results from a surgical and cosmetic viewpoint.

Biesenberger's criteria of an absolutely satisfactory mammaplastic result should be kept in mind: (1) The removal of breast deformity and construction of a youthful, natural and cosmetically satisfactory form by reduction in size to normal dimensions according to the general pro-

portions of the body; (2) symmetry; (3) preservation and transplantation of nipple and areola to their relative normal locations, increasing at the same time the areola in proportion to the newly formed breast volume; (4) prevention of possible obstruction of the blood circulation, above all, of the areola and nipple; (5) avoidance of interference with organic function; (6) avoidance of forming scars readily visible in clothes, particularly above the nipple; (7) use of a systematic surgical technic which can be carried out in all breast forms and dimensions, thereby facilitating adjustments to individual esthetic requirements; (8) one-stage operation; (9) proper use of elastic pressure bandages, and (10) careful elimination of unsuitable cases for psychic and physical reasons.



# FACTORS IN MALE STERILITY\*

## A CRITICAL REVIEW OF 135 CASES

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INTEREST in the study of sterility in the male has been stimulated by advances in diagnostic methods and endocrinological therapy. Investigators have stressed the necessity for detailed study of the sterile male and comprehensive consideration of all factors contributing to infertility. The extensive researches of Moench, Hotchkiss, and Portnoy<sup>4</sup> repeatedly emphasize the need for technical skill and understanding in interpretation of complete semen analyses. Despite recent contribution to our comprehension of the problem, there still remain many important questions in need of answer. The present study is based on examination and follow-up for five years of 135 cases with critical analyses of 500 semen specimens. In every instance, the marital mate was studied coincidentally by competent gynecological authority.

This work early suggested the necessity for meticulous study of the sperm morphology since approximately 20 per cent of the patients whom we found deficient in fertility had previously been adjudged normal. Therefore, classification of this series is based primarily on sperm count and morphological characteristics. Obvious congenital causes of sterility, such as, hypospadias, cryptorchidism, and abnormal attachment of the epididymis to the testis are granted no special emphasis since the problem is immediately apparent. We have concentrated rather on the cases in which diagnosis is obscure and pathological states are not readily identified.

### METHODS OF INVESTIGATION

The evaluation of male responsibility in the barren marriage is approached in our clinic with careful appraisal of all factors contributing to sterility. A systematized and routine form is essential. Thus a careful medical history is taken with emphasis on endocrinological and sexual factors. Physical examination is thorough and includes when necessary cystoscopic examination and catheterization of ejaculatory ducts. If abnormality is detected, x-ray and laboratory studies as may be indicated are made. In every case at least two semen specimens are taken; these are obtained by withdrawal and ejaculation into a glass container after the patient has abstained from intercourse for five days. The specimen is examined preferably within an hour or two for motility, volume, count, mucolysis, and differential morphological study. Criteria of morphology are those established by Pollak and Joel.<sup>13</sup> (Fig. 1.)

Motility of the sperm is determined by examination of a hanging drop and a calculation of the numbers of sperm which cross one-quarter of the microscopic field through an Ehrlich ocular screen in ten seconds. The ratio of this figure compared to the total number of sperm in the field provides the percentage of motility. A percentage of eighty or more after two hours is considered 4 plus; sixty to eighty 3 plus; forty to sixty 2 plus; and twenty to forty 1 plus.

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To determine the total sperm count, a well shaken specimen is drawn up to the 0.05 mark of a red cell pipette. A diluting

made and fixed by heat. MacNeal tetra-chrome stain is applied for three minutes after which distilled water is added for two

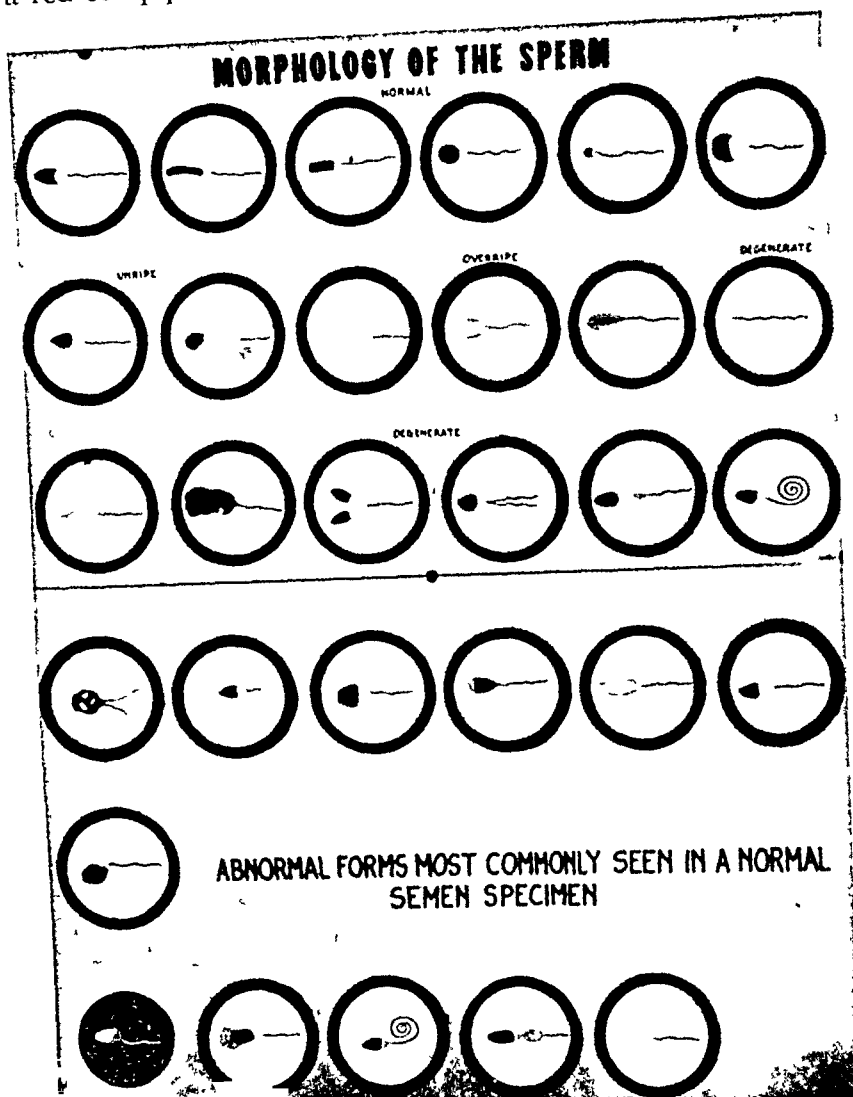


FIG. 1.

fluid consisting of a 4 per cent boric acid and 1 per cent phenol is then drawn up to the 1.01 mark. The mixture is shaken well, and a drop is placed on an improved Neubauer hemocytometer. Five of the red cell counting squares are calculated (one from each corner and one from the center to insure an average result). Six zeros ( $10^6$ ) are added to the total figure which gives the number of sperm per cc. Counts of 60 million to 120 million are considered normal.<sup>9</sup>

For histologic study a seminal smear is

minutes longer. The smear is then washed and dried and excellent visualization of the entire field is accomplished with this simple stain. The nuclei appear blue; cytoplasm, neck, and tail are strikingly pink. The routine use of this stain for seminal smear was initiated in our clinic. We consider a seminal specimen to be morphologically abnormal if there are more than 30 per cent of abnormal forms.

#### CLASSIFICATION OF CASES

Detailed analysis of 135 consecutive cases of sterile marriage indicated to us



that categorical classification in determination of male responsibility could be based on total sperm count and differential mor-

to be eight to thirty-six hours. Where abnormality was detected in count and morphology, corresponding failure in vi-

	Number of cases	Percentage	Range of total count	Activity	% of abnormal forms	Semen Analyses	Testicular Biopsy	Pregnancy	Infertility of mate
NORMAL	43	32	134 to 751 million	3 plus to 4 plus	9-30	102	0	10	19
LOW COUNT ABNORMAL MORPHOLOGY	34	25	1 to 69 million	0 to 2 plus	30-90	153	9	6	4
NORMAL COUNT ABNORMAL MORPHOLOGY	34	25	117 to 632 million	3 plus to 4 plus	35-81	167	6	9	1
AZOOSPERMIA	25	18	0	0	--	79	10	1	0
<b>TOTAL</b>	<b>136</b>					<b>500</b>	<b>25</b>	<b>25</b>	<b>24</b>

FIG. 2. Classification of cases.

phological examination of seminal fluid. Therefore, division was made into the following groups: (1) Normal semen analysis; (2) normal count; increased number of abnormal forms; (3) decreased count with increase in abnormal forms, and (4) azoospermia. (Fig. 2.)

The factors of motility and viability have been stressed by most investigators. Our experience has shown that in only rare cases in which there were normal count and normal morphology was there complete absence of motility. Impairment of motility indicated in most instances other defects. As regards viability, this series reveals striking variation with conception taking place where sperm activity was noted for only six hours. The usual range for the fertile specimen was found

ability occurred. However, it must be emphasized that in a group of cases in which viability and motility were normal, there was an increase in abnormal forms, this factor being accountable for infertility.

#### NORMAL SEMEN ANALYSIS

This group comprises 32 per cent of the cases studied. Meaker and Vose<sup>10</sup> report that in seventy-eight out of one hundred cases the responsibility for infertility was divided between husband and wife. They state that of all fruitless marriages, 30 per cent of pathologic conditions occur on the male side. Our series suggests that 68 per cent of the males showed defective semen.

Many of the subjects in this category were referred to us because their wives were undergoing concurrent studies by

gynecologists and infertility had not been definitely established in the female. In nineteen instances, the female had later factors are responsible for a certain number of these cases. In many no one etiologic basis could be determined. Biopsy of the

### REDUCED COUNT WITH REDUCTION IN ABNORMAL FORMS

NAME	DATE	COUNT PER CC	TOTAL COUNT	MOTILITY	VOLUME	% OF ABNORMAL FORMS	ABNORMAL FORMS										TOTAL
							HEAD CYTOL.	NECK CYTOL.	VALETS	POWERS	DEFECTIVE HEAD	ABNORMAL	DOUBT. HEAD	THICK NECK	SPERM. HEAD	SCISSOR TAIL	
F.J.	5-4-4	68	190M	2+	2.8CC	39	7	7	13	0	4	0	0	0	4	1	3
	5-25-4	73	113M	3+	1.6CC	23	6	3	6	0	5	0	0	0	4	1	2
E.B.	2-15-40	78	452	2+	58	81	0	15	18	0	17	4	0	11	0	3	13
	3-28-40	70	350	3+	5	78	0	12	28	2	11	3	3	0	7	0	12
	4-25-40	59	322	3+	58	36	0	3	12	0	10	3	2	0	3	0	5

FIG. 3.

been found deficient. However, the phenomenon of sterility resulting in a marriage in which both partners were physiologically normal is not unknown and this point is further emphasized in the current study. Factors as yet uncovered are responsible for these fruitless unions. In ten cases pregnancy subsequently occurred.

It is interesting to note that in several instances in which sterility was placed on the basis of low sperm count, although differential studies were normal, conception took place. Our standards for total sperm count, therefore, are much lower than those suggested by many investigators. Hotchkiss<sup>5</sup> has found in the fertile male counts as low as 3,250,000 per cc. Of 200 men whose wives were pregnant, 25 per cent had counts below 60,000,000 per cc.

#### LOW COUNT HIGH PERCENTAGE OF ABNORMAL FORMS (USUALLY WITH DECREASE IN MOTILITY)

In this division, etiology is variable and many responsible factors could be established. Thus in certain instances improvement resulted when foci of infection were discovered and cleared. This was true whether infection was confined to the prostate or seminal vesicles or resided in a distant focus. Circulatory disturbance to the testicle can provoke such irregularity. It is our impression that endocrinological

testicle in this group is a worthwhile diagnostic adjunct.

Our studies in general affirm the contention that there is an increase in abnormal forms with decreased count and conversely that there is a decrease in abnormal forms with increased counts. However, there are so many exceptions to this rule that one cannot make a universal application of this general principle. Figure 3 demonstrates two specific instances in which reduction in total count was accompanied by a reduction in percentage of abnormal spermatozoa. Figure 4 shows even more graphically how in the same patient variation in total count bore direct mathematical relationship to the percentage of abnormal forms.

It is significant that physical examination failed to disclose evident testicular disorders corroborating the opinion of Hotchkiss.<sup>3</sup>

#### NORMAL COUNT—HIGH PERCENTAGE OF ABNORMAL FORMS

The third group is comprised of those patients whose seminal deficiency is revealed only by morphological studies of the sperm. All other factors meet normal standards but there is an inordinate number of abnormal forms. There were thirty-four such cases or 25 per cent of the total series. It is in this group that diagnosis is most often missed because motility and

total sperm count give no clue to the irregularity. Many cases in this category had been declared normal by other observers

interesting to note that in the two patients who were exposed to x-rays, residents in radiology, semen analyses showed a large

### INCREASED COUNT WITH INCREASE IN ABNORMAL FORMS—

NAME	DATE	VOLUME	MOTILITY	COUNT PER C C	TOTAL COUNT	% ABN FORMS	HEAD CYTOPL	NECK CYTOPL	VACUOLE	PIN HEAD	OLIFORM HEAD	AMORPH	DOUBLE HEAD	THICK NECK	DEFORM NECK	DOUBLE TAIL	COILED TAIL
S.K.	8-27-40	3.0	3+	66	198	39	4	9	9	0	8	1	0	3	2	0	3
	10-25-40	3.5	4+	79	277	42	8	8	16	0	7	0	0	2	1	0	0
	12-12-40	3.5	4+	82	287	72	23	17	14	0	7	0	0	5	3	0	2

FIG. 4.

because careful morphologic studies had not been done. Since the sperm in these cases remained viable from eight to twenty-four hours, it is logical to assume that in specimens containing a high percentage of abnormal forms the spermatozoa may remain motile as long as sperm in normal specimens. Weisman<sup>15</sup> holds a contrary opinion.

It is realized from observation of this group that positive interpretation of Huhner's test<sup>6</sup> may be in error. Sperm may be present at the cervix in sufficient number with adequate motility but the test may be faulty because of the presence of an excessive number of abnormal forms. Any test which does not take into consideration the morphology of sperm may be wrongly interpreted.

Figure 5 represents a case originally adjudged normal since quantity and motility were within normal range but detailed examination of semen disclosed an excessive number of abnormal spermatozoa.

As yet testicular biopsy in this division does not add to our information since biopsy in six cases revealed normal spermatogenesis. In eight instances conception ultimately occurred.

Etiology is often elusive and there are apparently many factors causing a high number of abnormal forms. Some cases are the result of endocrine deficiency, others are due to foci of infection, exposure to x-rays, or dietary deficiencies. It is

number of sperm with excellent motility. The abnormal forms were mainly in the immature group, that is, those with cytoplasmic remains about the head and neck. The x-ray apparently had a stimulating effect producing an increase in spermatogenesis with the production of young forms. In those cases in which spermatogenesis is sluggish as demonstrated by low count, decreased motility or overripe forms, x-ray therapy in controlled dosage may be of value.

The following cases selected from this group are illustrative of successful therapy:

#### CASE REPORTS

**CASE I.** This was a barren marriage for three years. The wife was declared normal by a gynecologist; the husband was negative on physical examination but his basal metabolism was  $-28$ . The initial sperm analysis showed 56 per cent of abnormal forms. With gonadogen and thyroid medication, morphology was restored to normal. After eight months of therapy the wife conceived.

**CASE II.** This had been a sterile marriage for three years. Physical examination of the husband revealed no positive finding. His basal metabolism was  $-30$ . Previous seminal examinations were cursory and the patient had been thought normal. Originally 61 per cent of abnormal forms were seen on semen smear. The wife had had every test for fertility including tubal insufflation, endometrial biopsy, and Huhner's test and in every respect was declared normal. The patient was treated with thyroid

gr.  $1\frac{1}{4}$  daily. The wife became pregnant after nine months of treatment.

#### AZOOSPERMIA

Of all the problems in male sterility,

radiation therapy. In one instance it was discovered that both testes were intra-abdominal. It was possible to ascertain definitely that three such cases were referable to endocrinological dysfunction. The



FIG. 5. Microphotograph of seminal smear revealing high percentage of abnormal forms.

diagnosis in this group is simplest since absence of sperm count can readily be demonstrated. These cases fall into two groups: (1) Obstructive, in which blockage anywhere along the genital pathway prevents the appearance of sperm in the ejaculate; (2) degenerative, in which disturbance in the reproductive mechanism due to any cause prohibits the formation of spermatozoa.

Of the twenty-four cases reviewed, fourteen could be placed on a degenerative basis and ten on an obstructive. Differentiation between these two types can best be established by testicular biopsy. (Figs. 6 and 7.)

In the degenerative group, the etiologic factor could be determined in eight cases. Of these three had had mumps with complicating orchitis. One patient gave a history of seminoma with subsequent

etiologic background of six patients was never established. In only one case (Fig. 8) was improvement noted. A thirty-five year old male whose physical examination afforded no significant findings was found on initial analyses to have azoospermia. Complete studies revealed only a lowered basal metabolic rate ( $-15$ ). He was placed on therapy consisting of thyroid extract, corticosterone, and gonadogen. One month after the inception of therapy, a few dead sperm were visualized in the semen. Gradually improvement occurred in number, motility, and percentage of abnormal forms. Examination of the chart reveals that change in type of abnormality followed a definite pattern. There is a progressive shift from the large number of degenerative sperm to the type of alteration seen in the abnormal form which is commonly found in the fertile specimen (i.e., vacuo-

lated and those with cytoplasmic remains about the head and neck). After two years of treatment conception occurred.

spermia in which recovery of spermatozoa in the aspirate implied the presence of obstruction in the seminal tract. While rep-

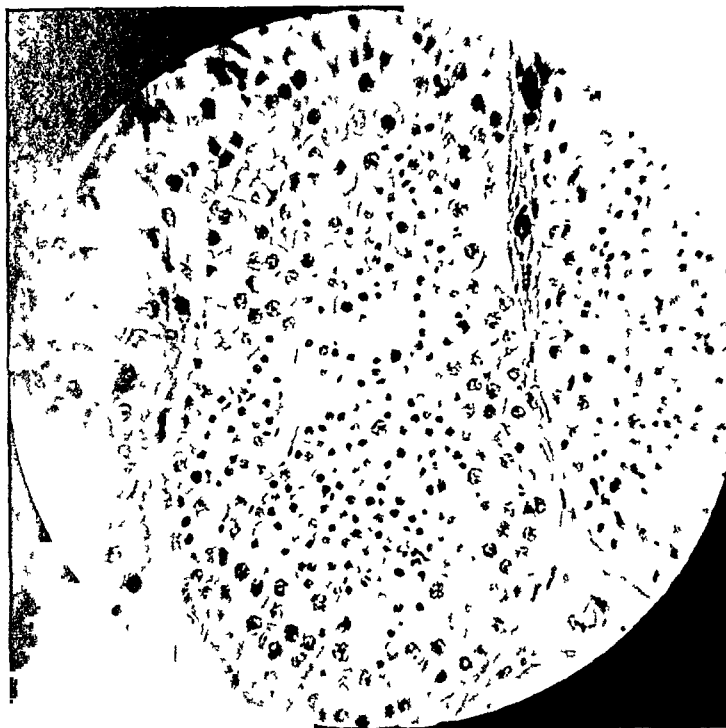


FIG 6 Microphotograph of testicular biopsy showing normal spermatogenesis

In all obstructive cases infection with secondary epididymitis was established as the etiologic background. The site of blockage was not always demonstrated. It is in this group particularly that exploration of the ejaculatory ducts may be of value. In four cases epididymovasostomy was performed, but in none of these were successful results procured.

Although prognosis in cases of azoospermia is very poor, we feel that in rare instances improvement may occur as suggested in the reported case.

#### TESTICULAR BIOPSY

Although the microscopic examination of testicular tissue had long been recognized as a valuable diagnostic measure in consideration of male infertility, no step was taken in this direction until 1913 when Huhner<sup>7</sup> introduced testicular aspiration. He advocated its use in instances of azoo-

representing an advance, this test had certain cardinal deficiencies. It often happened that for technical reasons no secretion was obtained. Inaccuracies sometimes resulted because puncture was made in a zone where seminiferous tubules were relatively inactive although elsewhere advanced spermatogenesis was present. The test was of value only in demonstrating the presence or absence of obstruction but made no effort to define intrinsic lesions of the seminiferous tubules. The microscopic examination of the testicular tissue removed by biopsy was introduced clinically by Hotchkiss to overcome these limitations of aspiration.

Testicular biopsy is a simple technical procedure. After preparation of the field, 5 cc. of 10 per cent novocaine are injected into the spermatic cord and over the site of incision. After an interval of fifteen minutes, an incision 1 cm. in length is made

down to the tunica albuginea which is nicked. A bit of the protruding testicular tissue is excised and immediately sent to

illustrative cases demonstrate the significance of testicular biopsy.

CASE III. This was a sterile marriage for

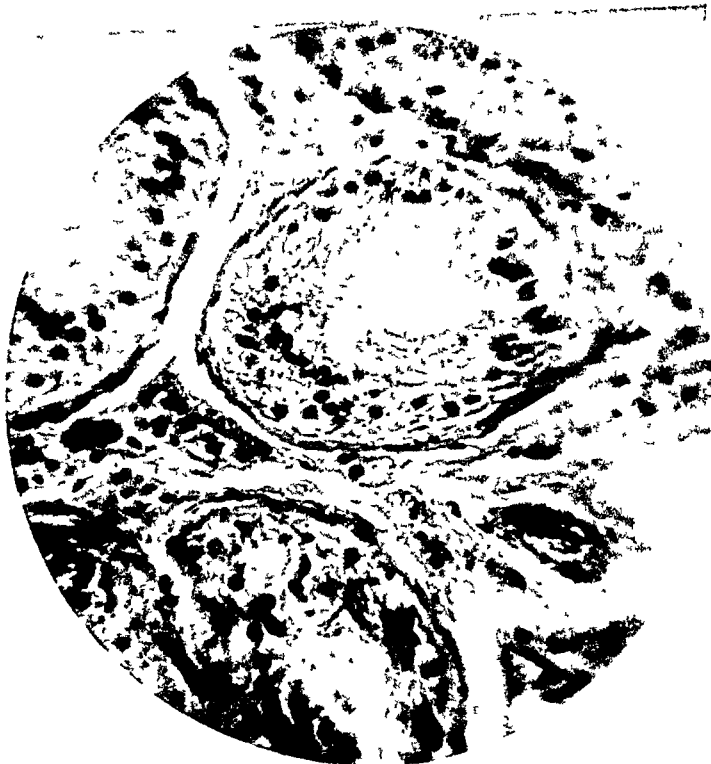


FIG. 7. Testicular biopsy with evidence of marked testicular degeneration. Only spermatogonia with thickened basal membrane are seen.

the laboratory for histologic examination. One suture is placed through the tunica albuginea and the skin is closed with one or two black silk sutures. This technic is painless, brief, and accompanied by no post-operative distress. Charny<sup>1</sup> lists the following indications for testicular biopsy: (1) In azoospermia to differentiate between the obstructive and nonobstructive types; (2) to determine severity of pathologic process; (3) as a prognostic gauge, to determine the capacity of tubules to regenerate, and (4) as a therapeutic measure, to evaluate by repeated biopsies the efficacy of therapy.

We have performed testicular biopsy in twenty-five cases and have found a striking relationship between semen analysis and the findings of microscopic examination of testicular tissue. In a series of ninety-five cases Charny and Meranze<sup>2</sup> have found correlation in 87 per cent. The following

five years. The male was in good health. Physical examination, laboratory and metabolic studies were negative. Semen examination revealed no sperm. Catheterization of ejaculatory ducts showed no obstruction. Testicular biopsy disclosed marked degeneration of the tubules showing only the basal layer of cells.

In this case therapy could be of no value because of the marked degeneration of testicular tissue. No therapeutic agent could restore such a striking atrophy.

CASE IV. This was a sterile marriage of four years' duration. The husband had had gonorrheal epididymitis five years prior to examination. Physical examination was normal. Semen analysis showed no sperm. Needling of the testicle was ineffective. Testicular biopsy revealed normal spermatogenesis and normal interstitial cells. In this patient sterility was therefore due to a block in the seminal tract. If obstruction could be overcome, conception would occur.



of infection disappeared the seminal secretions improved.

In those cases in which there was an excessive number of sperm with an inordinate number of abnormal forms of the immature type, small doses of testosterone propionate (10 mg. twice a week) caused a decrease in the number of sperm with a corresponding decrease in the abnormal forms.

Epididymovasotomy was performed in a number of cases in which an obstructive factor was established. Our results were poor. No pregnancies resulted following this procedure. In our studies, therapy in general has been disappointing. It is probable that in many of these cases in which we are giving endocrine therapy the primary offending factor produces a secondary effect on the endocrine glands, the primary cause of sterility being overlooked. Further diagnostic procedures may bring to light these primary causative factors in sterility, the correction of which will improve our results.

#### COMMENT

We have computed in an impartial manner the results achieved in an active sterility clinic over a five-year period. In this communication the technical diagnostic approach and consideration of laboratory criteria have been stressed. The necessity for meticulous examination of spermatozoon morphology in every instance of suspected male infertility has been pointed out.

Testicular biopsy has been found a valuable diagnostic adjunct, but must be employed in conjunction with detailed seminal studies. As a test its most frequent failure occurs in those instances in which the total sperm count is normal but an inordinately high percentage of abnormal forms are present.

Of the entire series reviewed, pregnancy ultimately resulted in 11 per cent, this bearing testimony to the relative inefficacy of our present therapeutic methods. We agree with Meaker and Vose in their con-

tention that constitutional deficiencies, such as chronic intoxications, malnutrition, and debilitating illnesses are potent factors responsible for infertility.

Our experience with a variety of hormonal stimulative therapeutic agencies has been disappointing. Where hypofunction of associated endocrines is revealed, as by basal metabolic rates and sugar tolerance tests, the deficiency must be overcome. Greatest success has been achieved in those cases in which thyroid dysfunction was proved. Kreutzman<sup>8</sup> states that only in cases of hypothyroidism has he obtained consistently good results. To stimulate spermatogenesis we have employed gonadogen, anteron, synapoidin, A.P.L. and antuitrin S. and have been unable to define significant differences in their value. On occasion, corticosterone has been employed as adjunct therapy. In those cases in which excessive numbers of unripe sperm exhibit excessive pituitary stimulation, testosterone in small doses may be indicated. In other cases degeneration of seminiferous elements of the testicle occurs with ultimate complete destruction if sufficient quantity is administered.

Because of repeated differential seminal analyses made during progression of treatment and employing a standard chart of abnormal forms, progressive alteration in sperm morphology has been observed. We have noted change following a definite direction. Where initially there is a preponderance of degenerate forms, change in these occurs, with improvement, to the immature and overripe spermatozoon until finally the greatest percentage show age changes rather than degenerative ones. We have labelled this phenomenon "shift to the left" because of directional change on our chart.

#### CONCLUSIONS

1. Analysis is made of 135 sterile marriages in which the male has been examined in our clinic.
2. Classification has been established on the basis of semen examinations.



3. The necessity is stressed for comprehensive appraisal of all factors to evaluate properly the status of the patient for there is no necessary relationship between motility, morphology, and sperm count.

4. Relationship between semen analyses and testicular biopsy has been considered. There is ordinarily striking correlation between these; exception occurs when total sperm count is normal but a high percentage of abnormal forms is present. Biopsy studies afford valuable diagnostic and prognostic aid.

5. Regeneration of testicular tissue in complete azoospermia with the final production of sperm able to induce conception has been demonstrated to be an uncommon but distinct possibility.

6. With progressive improvement in spermatogenesis changes are noted in the type of abnormal form in a definite direction from degenerative to the type of abnormal sperm most often seen in a normal specimen.

7. Endocrine therapy plays a limited rôle in most cases of male sterility.

8. A simplified technic for staining spermatozoa has been described.

We wish to acknowledge our gratitude to Doctor Clarence G. Bandler, Director of the Department of Urology, New York Post-

Graduate Medical School and Hospital for his assistance and guidance.

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# INTERNAL FIXATION FOR LUMBOSACRAL FUSION\*

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**D**URING the third of a century which has passed since Hibbs first described the spinal fusion operation, its field of usefulness has been widely extended. Recently the number of patients operated upon for removal of displaced intervertebral disc substance has increased tremendously and it has become apparent that some of these patients should have spinal fusions done at the same time. Unfortunately, the prolonged bed rest in plaster has always been a serious objection to the operation and has deterred many people from it. It is not my purpose in this brief paper to attempt to define the various indications for the lumbosacral fusion operation, but rather to describe an operative technic for fusing the lumbar and lumbosacral regions which furnishes immediate rigid internal fixation, thus eliminating the necessity for external fixation and prolonged bed rest.

## OPERATIVE TECHNIC FOR LUMBOSACRAL FUSION

The patient is placed prone on a hinged table and the lumbar lordosis partly obliterated by lowering both the head and foot ends of the table. The midline incision extends well down over the sacrum so that the muscles can be detached from its dorsal surface as far laterally as the posterior sacral foraminae. With a sharp elevator the muscles and ligaments are quickly and completely cleared from the fifth lumbar spinous process and laminae, and partially elevated from the fourth. This latter is necessary to get good exposure of the fifth. Interspinous, supraspinous ligaments, and all other soft tissues are carefully removed from the area to be fused. The lateral

articulations are exposed by dissecting and scraping away their posterior capsular covers and their joint spaces opened slightly by strong traction with bone hooks under the laminae. As much as possible of their articular cartilages is removed and then a flat, thin, flexible cautery tip is inserted into the joint and the remaining cartilage cauterized. The fifth lumbar spinous process is removed and put aside for use as graft material at the close of the operation. The sharp edge of the small osteotome, or a small gouge can be used to make a notch in the middle of the cortical surface of the inferior articular facet of the fifth lumbar vertebra for the reception of the tip of a No. 31 drill. This is necessary to prevent "wandering" of the drill point when it begins to rotate. If the drill is directed downward and outward parallel to the inferior edge of the fifth lamina (Fig. 1), the resulting tunnel will pass through the middle of the two facets that make up the joint and on into the lateral mass of the sacrum. (Fig. 2.) A vitallium screw† is placed in the tunnel, tightened, and the same procedure carried out on the other side. Rigid lumbosacral fixation can be demonstrated by seizing the stump of the fifth lumbar spinous process with a heavy Kocher hemostat and lifting toward the ceiling.

The remainder of the operation consists in elevating multiple small bone chips from the fifth laminae and the dorsal surface of the sacrum. Supplemental bone grafts from the ilium or tibia are always used by the author, ilial bone being preferred. In an occasional case in which the spinous proc-

† For women and small men three-fourth inch long; for large men one inch long.

\* From Department of Bone and Joint Surgery, Stanford University Medical School.

esses are well developed a tibial graft has been fastened directly on top of their stumps (Fig. 1) with short vitallium

amount of pain is definitely less and this, coupled with the absence of a cast, diminishes the opiate-distention cycle. Many of

FIG. 1.

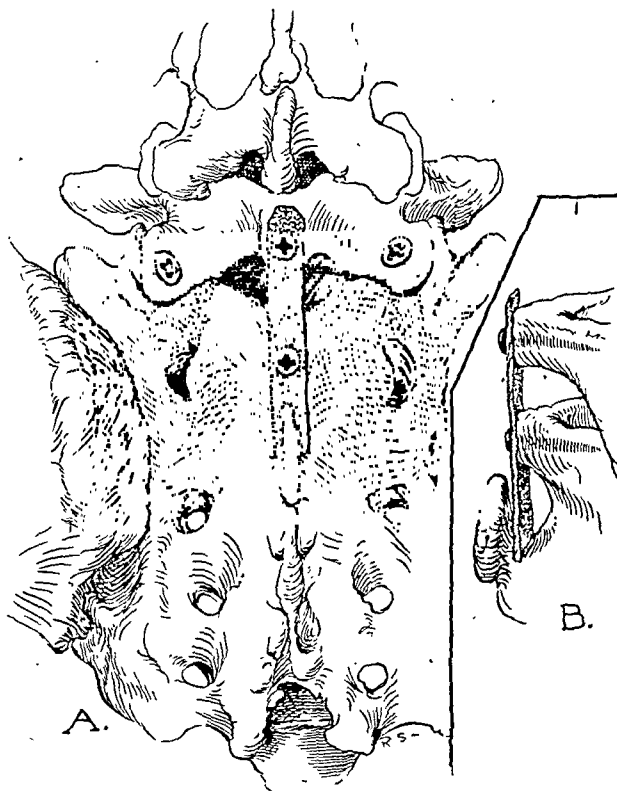


FIG. 2.

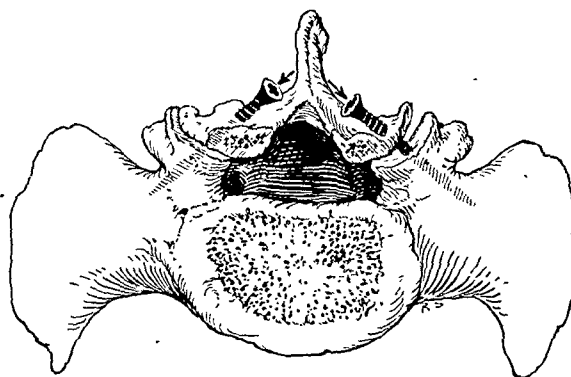


FIG. 1. A, posterior view of lumbosacral joint showing screws through lateral articulations and tibial graft screwed to spinous processes. Multiple chip grafts are not shown. B, lateral view showing tibial graft.

FIG. 2. Sacrum and arch of fifth lumbar vertebra (from above) illustrating direction of screws.

screws. After closure several drain pads are snugly strapped over the wound with adhesive, but no brace or cast is used.

#### POSTOPERATIVE CARE

The patients are allowed to move about at will. Since internal fixation is rigid the

the patients are up and about in ten days but the average is about three weeks.

#### COMPLICATIONS EXPECTED AND REALIZED

We expected to see an occasional postoperative facet fracture originating in the screw hole. Actually, we have not as yet

been able to demonstrate this complication. In one patient there was persistent burning pain in the distribution of the

upward traction made with a rope passing over a ceiling pulley. It was found that small and medium sized cadavers could be



FIG. 3. Case 1. X-rays taken fourteen months after operation. Top right shows excellent posterior bony bridge. Bottom left and right are oblique (sixty degree) views to show lateral articulations.

fifth lumbar nerve root on one side, necessitating the removal of the screw. In a series of thirty fusions we have had one postoperative infection. The screws and grafts were removed during the second postoperative week.

#### DISSECTING ROOM EXPERIMENT

In order to test the strength of the facets and rigidity of the fixation the operation has been done on fresh cadavers. With the cadaver in the prone position a hook was placed under the fifth neural arch and

raised from the table without the fixation giving way. In one very heavy cadaver, just as the trunk cleared the top of the table, with legs and arms still touching, the laminae fractured on either side of the hook under the spinous process. In another heavy cadaver the arch gave way bilaterally at the screw holes.

#### CASE REPORTS

CASE 1. The operation was performed June 10, 1942. A. B., a female, age thirty-five, had had low backache off and on following an

automobile accident twelve years ago, in which her spine was "wrenched." During the past four years the back had bothered her con-

of the intervertebral disc between the third and fourth lumbar spinous processes.

At operation the neurosurgeon did a right



FIG 4 Case II. X-rays taken one year after operation. Top left: anteroposterior arrow marks site of laminaectomy. Two lower films are left and right oblique views (sixty degrees) to show the lateral articulations. Note complete disappearance of joint spaces.

stantly and she had had several attacks of sciatica on the right side. She had used fracture boards in her bed, manipulative treatments by chiropractors, and osteopaths, had worn surgical corsets, a lumbosacral brace, and a lumbosacral plaster cast. This last form of treatment gave considerable temporary relief.

Examination showed a flat lumbar spine with muscle spasm, tenderness over the lumbosacral region, a positive straight leg raising sign and a slightly weak knee jerk on the right. There was no history of rheumatism, and the sedimentation test was normal.

X-ray studies (Fig. 3) showed some thinning

laminaectomy on the third lumbar and so damaged the lateral articulation that a screw could not be placed on that side. However, as indicated in the "x-rays," screws were used in the articulation on the left side and in the lateral articulations between the fourth and fifth lumbar vertebrae, and between the fifth lumbar and first sacral, reinforced by bone grafts from the tibia.

She remained in bed four weeks, no post-operative support being used. At the present time she has an excellent fusion, the backache has disappeared but she still has some aching

pain in the right sciatic distribution if she is on her feet for a long time.

CASE II. A. C., a twenty-six year old nurse, suffered from right-sided sciatica for one year

Examination disclosed a stiff lumbar spine, moderate atrophy of the left lower extremity, absence of the left Achilles reflex, and definite weakness of the peroneal muscles.

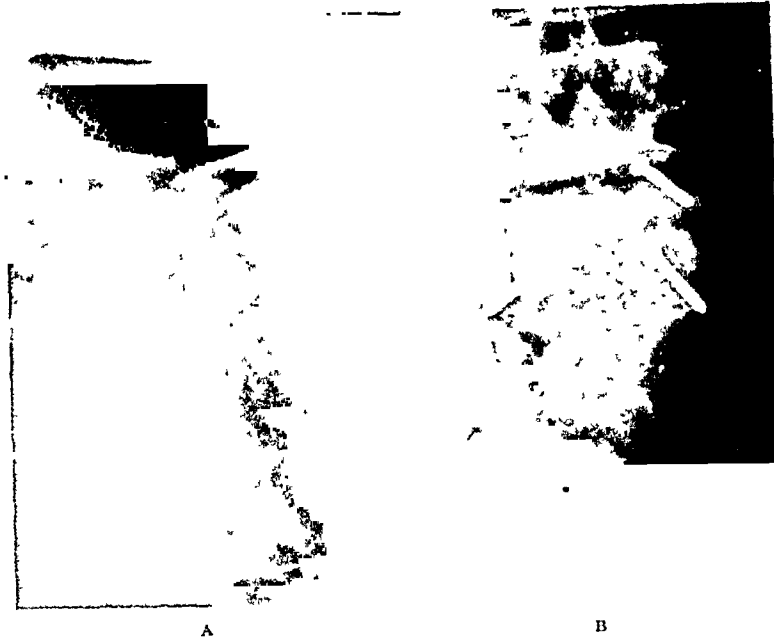


FIG. 5. Case III. Anteroposterior lateral X-rays one and one-half years post-operatively.

before admission. Her neurosurgeon thought she had a posterior herniation of the fourth lumbar intervertebral disc but on doing a laminectomy (September 6, 1942) found nothing. The author was called to the operating room, and after reviewing the X-rays, which showed some degenerative arthritis in the lateral articulations, scrubbed up and placed the screws as shown in Figure 5. No grafts were used.

There was immediate relief of the sciatic pain. She remained in bed three weeks, returning to work eight weeks after becoming ambulatory. No postoperative support was used. She has remained well.

X-rays (Fig. 5) one year after the operation reveal bony fusion of the lateral articulations.

CASE III. I. J., a thirty-seven year old female secretary, entered Stanford University Hospital March 6, 1942, complaining of chronic backache. This had bothered her off and on for at least fifteen years. There was an insidious onset without trauma. During the year preceding her entry she had almost constant left sciatic pain.

X-ray studies revealed some loss of the fourth lumbar intervertebral disc with degenerative arthritic changes.

Operation was done on March 8, 1942. Laminectomies at the fourth and fifth discs failed to disclose a posterior herniation. A fusion of the fourth and fifth laminae to the sacrum was carried out, using the technic described. No postoperative fixation was used and she remained in bed four weeks.

When last seen, September 19, 1943, she was well, having returned to work three months after the operation. The Achilles reflex was still missing. (Fig. 5.)

#### SUMMARY

Rigid fixation of the lumbar joints can be secured by placing screws through the lateral articulations. The technic is described. Bone grafting, in the usual way, can supplement this fixation. No prolonged bed rest, cast, or brace is necessary. X-rays of three cases are shown to illustrate the technic.

# SCLEROTHERAPY OF VARICOSE VEINS

## UTILIZATION OF AN INTRAVENOUS AIR BLOCK

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THE treatment of varicose veins by injection with sclerosing agents, especially when preceded by high ligation of the saphenous veins, is an effective and time-tested therapy, supplanting the older radical operations of Schede, Mayo, Rindfleisch or Babcock.

The advantages of sclerotherapy are low morbidity, almost no mortality and no necessity for hospitalization, therefore, avoiding loss of working time. The mortality amounts to about 0.007—0.3 per cent (Westerborn, Ochsner, McPheeters).

The disadvantage is the very high incidence of recurrence. Ochsner, Howard, Jackson and Mahon estimate recurrence as high as 60 and 79 per cent. This high percentage, however, can be considerably reduced by combining the sclerotherapy with surgical procedures such as high ligation (Trendelenburg, Moschkowitz), retrograde injection of sclerosing agents, as introduced first by Unger and later repeated by Pratt, multiple ligations in the region of the venae perforantes, and extirpation of excessive large varicosities (Madelung operation). This combined method reduces the percentage of recurrence as low as from 10 to 16 per cent (Ochsner, McPheeters, Sarma) which compares favorably with the percentage of recurrences following radical operative methods of Babcock, etc., (18 to 20 per cent; Ochsner, and McPheeters).

The mortality of the radical surgical methods is high (1 per cent; Mueller and Ochsner) and can be reduced by using the combined method (0.4 per cent Kilbourne). It should be possible to reduce the mortality even more by proper selection of the cases, by keeping the operative

measure as minimal as possible, and by keeping the patient ambulant.

The aim of sclerotherapy is to bring about a necrosis of the endothelium of the vein, leading to the formation of a chemical red thrombus which firmly adheres to the venous wall.

In order to bring the sclerosing agent in direct contact with the endothelium, the vein should be freed from blood before the solution is injected.

The simplest and, therefore, the best method, is the following: With the patient lying on the table, the legs hanging down, one tourniquet is applied above, and a second tourniquet below the vein section to be treated. After the needle is inserted, the leg must be raised from 45 to 90 degrees above the horizontal plane. The upper tourniquet is then released; after the vein is empty, it is re-applied, and the sclerosing agent injected into the vein.

This technic requires a certain amount of skill and at least one assistant. The syringe must be kept very steady, so as not to pierce the opposite veinwall. Once the vein is empty, the operator has no evidence whether his needle point is still inside the vein or not.

This method cannot be used in all instances, especially not where the lumen of the vein is small, or where the veins are only prominent with the patient in standing position. In these cases, the solution must be injected into the filled vein ("full vein technic"—P. Riddle), a procedure which very often is followed by failure.

In the course of twenty years' practice, the writer encountered numerous non-takes with both methods, requiring repeated injections into the same vein

sectors. Although strong solutions, such as hypertonic sodium chloride or 10 per cent sodium morrhuate, were used, a satisfactory sclerosis could not be effected. These were veins which could not be emptied satisfactorily; some of them showed fibrotic, rigid non-collapsible walls, others were found to be at the dorsum pedis, and near the malleoli and others were thought to be in the vicinity of the rami perforantes.

In searching for a more effective and easier applicable method, the author adopted the idea of introducing air into a closed vein sector, with the aim in mind of expelling the blood completely from a small portion of the blocked sector, following which the sclerosing agent is injected into this air-filled space.

*A priori*, it was conceded that the contact between the agent and the endothelium is of very short duration but sufficient to bring about instantaneous endothelial-necrosis. Following this phase, the agent, diluted with blood, gradually exerts the same effect as is expected and obtained by the full vein technic.

To demonstrate the physics of induction of air into a tubular system, the following experiment was done (Fig. 1):

An intravenous set is filled with water, and the air removed from its tubing. In order to eliminate the negative pressure prevailing inside the system, the section of the tube in which the experiment takes place is clamped off bilaterally. The observation may easily be made by using a transparent tubing placed in front of an intensive light.

*First Experiment.* One cc. of tinted solution (eosin- or mercurochrome solution) is injected into the tubing. As soon as the liquid enters the tube it mixes readily with the water, forming a red column which gradually descends to the lowermost clamp, reaching it after forty-five seconds, and having covered 37 cm. of tubing. (Diameter of the lumen: 6 mm.)

*Second Experiment.* A syringe containing 1 cc. air and 1 cc. of mercurochrome

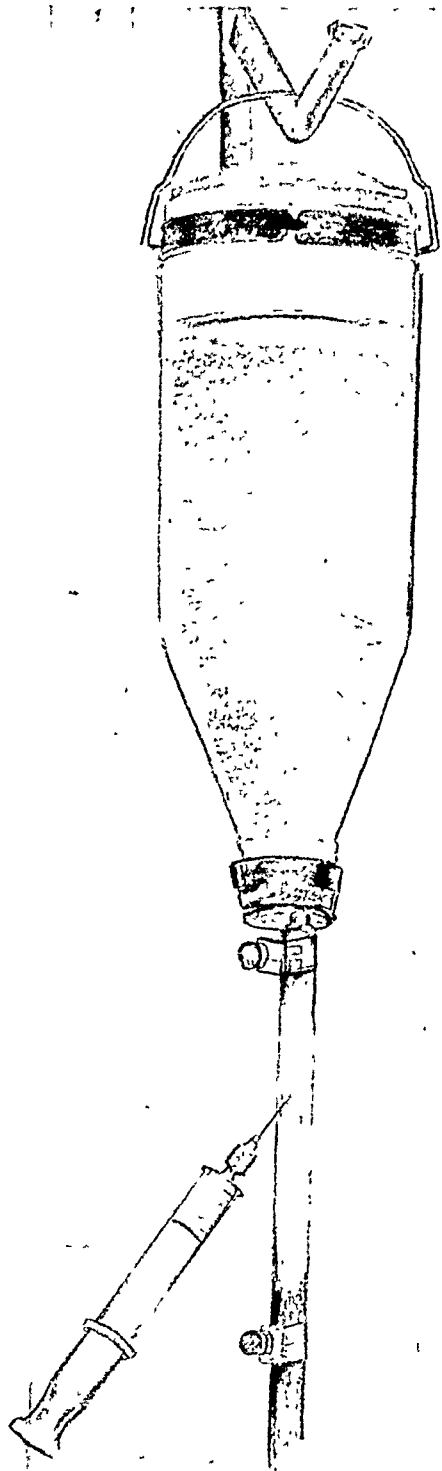


FIG. 1. A transparent and bilaterally clamped-off tubing of a water filled intravenous set is used for the experiment; 1 cc. of a tinted solution is injected into it. Then the injection is repeated after preceded injection of 1 cc. of air. The physical phenomena of both experiments, observed in front of a strong light, are described in the text.



solution is held with the needle upward and first the air, and then the mercurochrome is injected into the tubing. When the injection is done very slowly, individual air bubbles enter the water in the tube and rise toward the upper clamp. With a speedier injection, only a few individual air bubbles escape upward, and nearly all of the air in the syringe forms an air block, displacing the water. As soon as the mercurochrome enters this air space it descends to the lower level of the air block, where it mixes with the water. The injected solution does not fall through the air space, but is distributed along the wall of the tubing before accumulating at the bottom of the air section. There is a similarity between this phenomenon and the distribution of food inside the stomach, the meal using the route of the lesser curvature to reach the pylorus. With the injection done fast a layer of undiluted solution replaces a part of the air space for about three to five seconds. In about forty-two seconds all the water between the two clamps is tinted red—three seconds less than in the former experiment, due to higher intratubular pressure caused by the inflation of air. After completion of the experiment about 0.15 cc. of air can be recovered from the tubing.

Studies of venous pressures show that when patients with varicose veins are in the standing position, the saphenous pressure corresponds closely with the hydrostatic pressure (H. S. Mayerson, et al.), therefore, permitting the above experiment to be drawn into consideration as a comparative, easily demonstrable theoretical basis.

The technic of creating an intravenous air block is simple. With the patient standing or sitting, a tourniquet is applied above the vein to be treated. (In my latest series I omitted the tourniquet.) The syringe is held with the needle upward, so that air is above the level of the agent. After insertion of the needle into the vein, indicated by appearance of

blood in the syringe, the air is injected and, with one continuous movement, the sclerosing solution.

The amount of air to be injected should equal the amount of the sclerosing agent, but should never exceed 3 cc. in amount.

After completion of the procedure, a piece of gauze is tightly applied to the site of the injection, and kept in place with adhesive tape, and finally, the leg is supported by an elastic bandage.

In injecting superficial and transparent veins, it can be clearly seen how the entering air expels the blood from the vein, and how the solution replaces the air-filled space. In all such cases, an instantaneous formation of a chemical thrombus is noted.

For fear of air embolism, the first injections were done on such patients only who had high and multiple ligations; later on this method was employed on patients who had not had previous ligation. In a series of 297 cases, no air embolism has occurred. There was only one incident, which, *prima vista*, appeared to be caused by air embolism, but later on proved to be an acute quinine poisoning.

A sixty-four year old man with excessive superficial ulcerations on both lower legs and third degree varicose veins, refused surgical intervention. He received eighteen injections of 5 per cent sodium morrhuate, ranging from 1 to 2 cc. for each vein sector. The last three injections were done with the air block. They were tolerated with no untoward effects. At the fourth injection, for which quinine urethane was used, the patient experienced heat sensation in his head, his face became flushed, he became slightly irrational and disoriented. There was no change in temperature, pulse or blood pressure and no respiratory embarrassment. After one hour the patient was able to reach his home by taxi.

These symptoms do not resemble those of air embolism, in which one finds cyanosis, dyspnea, shock, slow pulse, convulsions (G. R. Osborn et al., H. M. Wyrauch, Pompe, McDaniel, Chase). A diagnosis of acute quinine poisoning was

made and confirmed a few days later when the patient appeared with a typical quinine rash.

Introduction of air, in small amounts, into the venous system, does not lead to clinical air embolism. It appears that air in small amounts does not reach the pulmonic circulation, being entirely absorbed on its way centrally.

According to H. F. Richardson, B. C. Colles, G. E. Hall, J. B. Wolfe, and H. F. Robertson, 480 cc. of air entering the venous system within twenty to thirty seconds will cause death in a person weighing 60 kilograms. The writer was unable to find in the literature any instance of fatalities when air entered the saphenous vein or its tributaries.

Lethal embolism was reported when air entered the thorax (Borack and Wilder), the knee (insufflation), the bladder (after diagnostic insufflation—Jockisch), the uterus (pregnancy, abortion—H. H. W. Petri), the perirenal space (insufflation for x-ray diagnosis Weyrauch), the elbow vein (Pompe), and the cervical veins (Larson et al., K. Neller).

The therapeutic effects with the described method are very satisfactory. The percentage of takes is considerably higher than with the conventional methods. In some cases, the phlebitic reactions seem to be slightly more pronounced. However, this can be successfully counteracted by application of supporting and compressing bandages, and by the use of external heat.

The described method should not be used for the sclerotherapy of large varicose veins. Here the conventional method has its place. Medium and small veins for which usually the "full vein" method is employed, are the field of the described technic.

Two safe-guards may be mentioned: (1) For each injection a new sharp needle, No. 22 gauge and up, should be used. (2) Never should a vein be injected which is not readily accessible. If, after the initial thrust of the needle, blood does not appear

in the syringe, a different site should be chosen.

#### SUMMARY

1. Conservative surgery and sclerotherapy give satisfactory results in the treatment of varicose veins, with short or no hospitalization, low morbidity, and very low mortality.

2. Injection of a small amount of air into a varicose vein prior to injection of the sclerosing agent, expels the blood out of the vein sector, and allows the sclerosing solution to act upon the endothelium undiluted, producing a firm chemical thrombus.

3. The theoretical basis of the air-block method is discussed.

4. The air-block method does not replace the conventional methods. It supplements them, and should be used only for medium and small veins.

5. There is no danger of air embolism with introduction of small amounts of air into the superficial veins of the legs.

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*Urology Award.*—The American Urological Association offers an annual award "not to exceed \$500" for an essay (or essays) on the result of some specific clinical or laboratory research in Urology. The amount of the prize is based on the merits of the work presented, and if the Committee on Scientific Research deem none of the offerings worthy, no award will be made. Competitors shall be limited to residents in urology in recognized hospitals and to urologists who have been in such specific practice for not more than five years. All interested should write the Secretary, for full particulars.

The selected essay (or essays) will appear on the program of the forthcoming June meeting of the American Urological Association.

Essays must be in the hands of the Secretary, Dr. Thomas D. Moore, 899 Madison Avenue, Memphis, Tennessee, on or before March 15, 1945.

# PITFALLS TO BE AVOIDED IN CHOLECYSTECTOMY

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THE progress made in the surgery of the gallbladder has been one of the great triumphs of operative therapy, and the story of this advance is a fascinating one. A discussion on problems in cholecystectomy would therefore seem presumptuous. And the writer would not consider submitting this paper were it not for the fact that the anatomical and technical pitfalls are still not fully appreciated. Too many common ducts are still being cut during cholecystectomy.<sup>1,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39</sup>

Technically, gallbladder surgery is the most difficult and dangerous of any abdominal surgery, and an inadequate appreciation of the variations and abnormalities of this region is responsible for increased mortality and morbidity. The development of improved surgical technic, improvement in preoperative preparation, anesthesia and postoperative management have been important factors in reducing the mortality. In the past fifty years the mortality from operations on the biliary tract have been reduced from 16 per cent (Courvoisier, 1889<sup>23</sup>) to 3 per cent or less (Berkson<sup>24</sup>). However, in the hands of those not especially trained mortality still rises to 10 per cent or even higher.<sup>3</sup> Mortality advances rapidly with age. The mortality is greater in males than in females.<sup>3</sup> Morbidity from bile duct injuries usually go unreported, and hence any estimate of this incidence would be inaccurate. The sequelae of accidental division or excision of a segment of the duct or its inclusion in a ligature during cholecystectomy are such that irrespective of surgical repair of the injury the end results are usually poor. Bakes<sup>4</sup> observed bile issuing from the wound 230 times in 246 cases of simple

cholecystectomy—an indication of either a severed accessory bile duct or injury to the bile duct apparatus. Injury to the bile ducts continues to be one of the most significant operative complications. Hence many surgeons have justly stressed among the pertinent factors in reducing mortality and morbidity in cholecystectomy, an intimate knowledge of the common and special anatomy of the bile duct apparatus.<sup>5,15</sup>

These are the days of frequent cholecystectomy, the operation most commonly performed on the biliary tract. Outside of the appendix the gallbladder more often calls for operative treatment than any other intra-abdominal viscus. But if we may judge from the great number of patients unrelieved or requiring a second operation, or the number of strictures of the common duct which occur, there would seem to be room for improvement. Though quite a large number of injuries to the bile ducts have been reported by various authorities, notably Eisendrath,<sup>17</sup> Elliot,<sup>18</sup> Lahey and Walters,<sup>11</sup> these probably represent only a small fraction of the total number, for surgeons do not feel disposed to advertise their errors. That the incidence of duct injury is higher than the inadequate statistics would indicate, is borne out by the numerous reports of methods of reconstruction of bile ducts injured during cholecystectomy. A book by Hargan<sup>6</sup> on the methods of reconstruction of the biliary tract further serves to emphasize the frequency of severe injuries and their great significance. More recently Pearse<sup>7,16</sup> has described the use of vitallium tubes for repair of injured bile ducts and states that common duct strictures are traumatic in origin and are the direct result of cholecystectomy in from 80 to 90 per

cent of the cases. With the increased number of cholecystectomies, complicated surgery of the bile ducts has multiplied.

structures are in a dark deep hole, the sides of which are kept in constant motion by the diaphragm. Another source of considerable

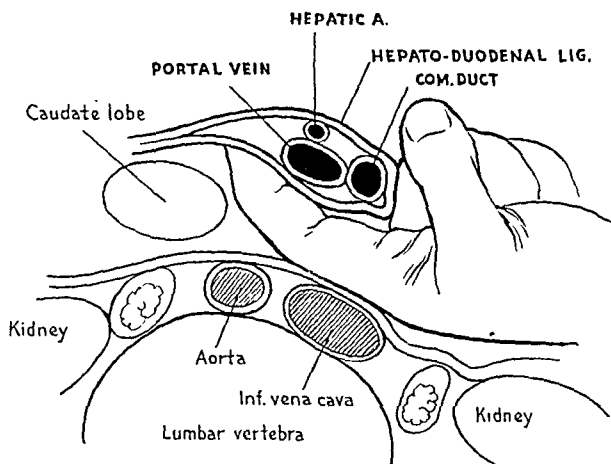


FIG. 1. Shows the left index finger in the foramen of Winslow. Note the common duct, hepatic artery and portal vein in the hepatoduodenal ligament. Raising the ligament interrupts the blood supply to the liver. The hepatic artery may be compressed here for the control of hemorrhage from a torn or slipped cystic artery during cholecystectomy. Related structures in this vicinity are illustrated.

What are the reasons for these anatomical and technical difficulties in cholecystectomy? The anatomy in the region of the gallbladder makes good exposure difficult. The bony framework of the lower wall and the bulk and immobility of the liver, plus its peculiar shape all help to

difficulty is the deep situation of all structures under the liver. The structures are short and the right lobe of the liver hides the hepatic and cystic ducts. Add to this a fat patient taut and heaving from insufficient anesthetization and safe cholecystectomy may well nigh be impossible.

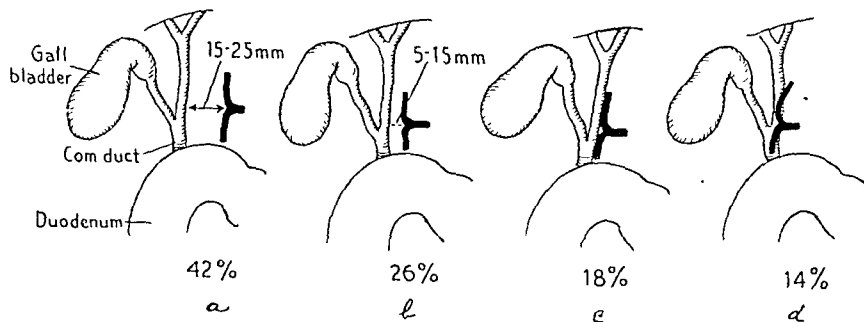


FIG. 2. Shows a relationship of the hepatic artery to the common duct. Figure *d* illustrates a particularly dangerous situation present in 14 per cent of cases according to Rio Branco when the hepatic artery overlies the common duct. This relationship should be kept in mind during choledocotomy, and the hepatic artery sought for and displaced before incising the duct.<sup>43</sup>

obscure the operative field. The close proximity of the stomach and colon add to the surgeons difficulties. Maintenance of adequate exposure is trying because the

When the above handicaps have been surmounted, the factor of variations and anomalies enter and these are of the utmost importance, since every possible variation

can become an actuality. The occurrence of these variations receive either no mention at all or only a brief one in most all of the main hepatic and the cystic duct. (Fig. 2.) We have been taught and still are taught that the cystic artery is a single

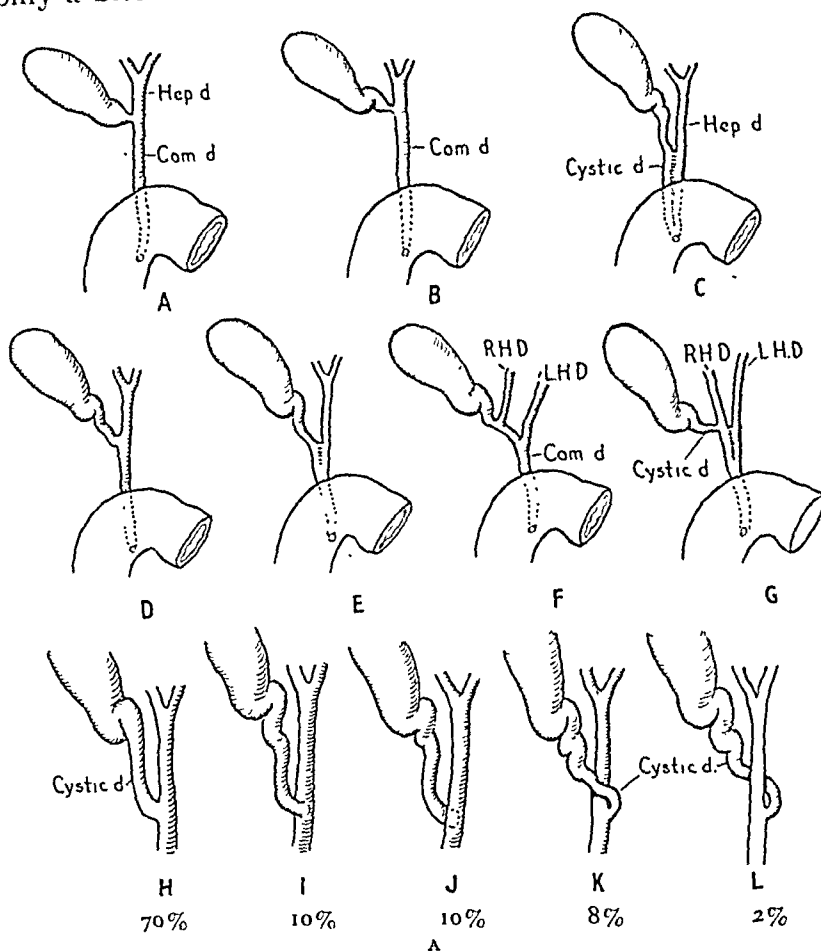


FIG. 3. A, A to E illustrate different relationships of the cystic to the common hepatic duct. The relationship illustrated in C occurs in 24 per cent of cases according to Descamp. This is surgically important. F illustrates an anomaly of the right hepatic duct. G illustrates the cystic duct terminating in the right hepatic duct. H to L illustrate various modes of entry of the cystic into the common hepatic duct and the approximate incidence according to Descamp.<sup>21</sup> K and L illustrate the anterior and posterior spiral modes of entry of the cystic into the common hepatic. The presence of a stone in the cystic duct in K and L could produce clinically the same symptoms as that of common duct obstruction. The removal of a stone from the cystic duct in either K or L could easily result in injury to the common duct unless this anatomical relationship is kept in mind. The spiral mode of entry occurs in 8 per cent of cases according to Descamp and 37 per cent of cases according to Ruggi.

of our standard textbooks of anatomy and operative surgery. The anatomical teaching is, that there are two bile ducts one from each lobe which join close to the liver to form the hepatic duct, and this is joined shortly by the cystic duct at an acute angle, and that the common duct is a single structure which is formed by the union

vessel arising from the right hepatic, shortly after the latter passes behind the main hepatic duct. The common duct is described as being sufficiently devoid of large blood vessels on the anterior surface of its supraduodenal portion to permit of easy access to an incision in this portion, as the best approach in the removal of

stones from the common duct. If the above teachings were correct, we would not encounter any special technical difficulties.

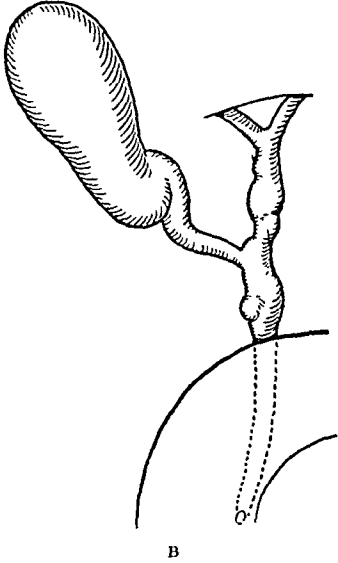


FIG. 3. B, a drawing of the author's dissection showing herniations or parietal sacculi in the wall of the common duct. These outpouchings usually contain no muscle fibers and consist of mucous membrane and adventitia. They are easily torn or ruptured.

There would be fewer injuries to the hepatic and common duct with fewer strictures of the common duct. The right

glycemia and death,<sup>8</sup> and accidental division of the common bile duct has occurred during cholecystectomy by experienced surgeons.<sup>9</sup> In a review of forty-seven cases of strictures of the common duct, Judd noted that all but five followed some type of operation on the gallbladder or ducts. No less an authority than Doctor Lahey states that practically all strictures of the common and hepatic ducts are man-made strictures.<sup>10</sup> In support of this contention it may not be amiss to relate an incident which occurred in the practice of one of the most skillful and experienced surgeons in the country. He had completed a cholecystectomy and closed the operative wound. He was about to leave the operating floor when he bethought himself to examine the specimen. To his consternation he found a portion of the main duct attached to it. A second operation was done with a very happy result. If such a thing can happen to one of our great surgeons, how much more likely is it to occur in the work of the average surgeon. This serves to illustrate the necessity of careful examination by the surgeon of the specimen immediately after cholecystectomy. Delayed operations for the repair or reconstruction of bile ducts are ex-

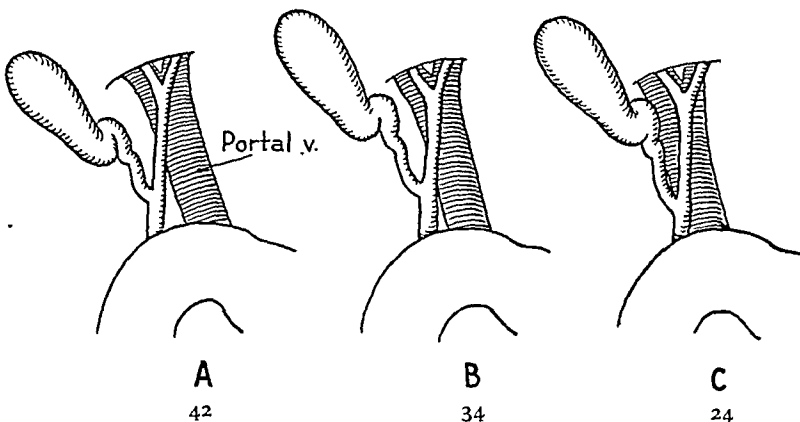


FIG. 4. Illustrates the relationship of the portal vein to the common duct. The relationship is especially close in 24 per cent of cases as illustrated in c; and injury to the portal vein can occur if the common duct is not opened carefully or during repair of a strictured common duct. Kehr and Lahey report injury to the portal vein during operative procedures in this region.

hepatic artery has been damaged and ligated with resulting progressive hypo-

tremely difficult and must often be performed on deeply jaundiced and otherwise

incapacitated patients. The mortality is, therefore, high. Those who recover, frequently after multiple operations, are doomed to ill health, recurrent fever, chills and jaundice.

To avoid errors in operative technic a thorough familiarity with every possible variation in the biliary tract is mandatory, for prevention of injury is of paramount importance. And prevention may be facilitated only through the possession of an intimate knowledge of the variations of ductal and vascular structures. While human beings are singularly alike in their general anatomical construction, yet when one comes to investigate any particular region with more detail, it is surprising how frequently we meet with variations of one sort or another. More especially does this apply to the vascular system and in no region more than in the liver. This I think is generally appreciated by anatomists. My professor of anatomy, the late Doctor Stockhard, of Cornell used to say that if we all had a transparent abdominal wall, we would know each other by the appearance of our viscera, so great are the variations of the normal. Flint<sup>13</sup> after 200 dissections of the gallbladder and ducts found only sixty-nine cases of so-called normal. He states that the variations are so frequent that it is impossible to regard any one type as normal. Anatomical studies by Ruge,<sup>19</sup> Kurz<sup>20</sup> Descamp,<sup>21</sup> Behrend,<sup>22</sup> and Eisendrath<sup>17</sup> have shown for example that there are two cystic arteries in 12 per cent of individuals, a fact generally not appreciated by most surgeons. Descamp<sup>21</sup> believes that 18 per cent is more accurate. At any rate it occurs often enough to put the surgeon on his guard when he has ligated only one cystic artery. (Fig. 6.) To anticipate any normal arrangement of the bile structures is to invite disaster. The writer has therefore summarized the more important variations and anomalies of the bile ducts and the related blood vessels with which every surgeon should be familiar. These anatomical variations may further be distorted

by pathological changes. This multiplicity of variations and anomalies, further multiplied by the pathological distortions

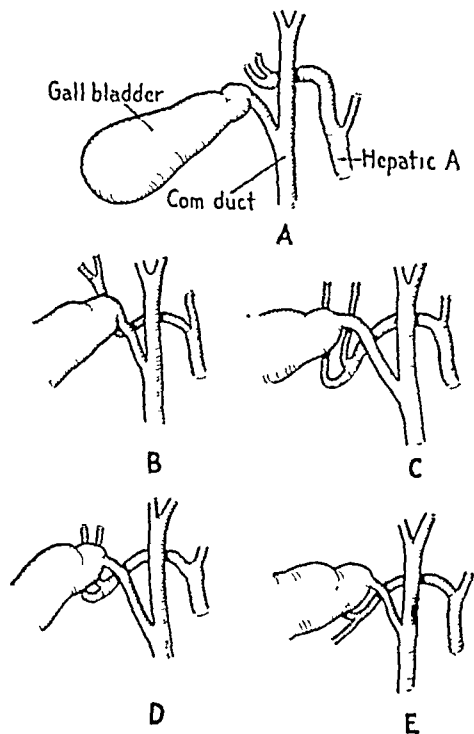


FIG. 5. Relationship of the right hepatic artery to the cystic duct and neck of the gallbladder according to Rio Branco. A and B represent the usual relationship; C and D a rather frequent occurrence; E a rare relationship. These figures illustrate Calot's triangle with the right hepatic artery as the northern boundary rather than the cystic artery. Ligation of the right hepatic artery in this location for the cystic artery results in hypoglycemic shock and death.<sup>21,43,45</sup>

indicates the serious problems which frequently confront the surgeon during cholecystectomy.

Variations in the bile ducts and in the cystic artery are the more frequent causes of accidental injury to the ducts during cholecystectomy. (Figs. 3 and 6.) Though the gallbladder and the cystic duct are the ready guides to the common duct, it should not be forgotten that the cystic duct is not at the bottom of the gallbladder, but to its inner side, and that the pelvis of the gallbladder may overlap the cystic duct and cover the preduodenal common duct. (Fig. 8F.) The cystic duct varies in size as shown by recent studies.<sup>11</sup> In



55 per cent of cases the duct is believed to be from 2 to 4 cm. long; in 25 per cent more than 4 cm. in length, and in 20 per cent less

hepatic duct. Careful examination should, therefore, be carried out to determine the anatomic relation and it may be assumed

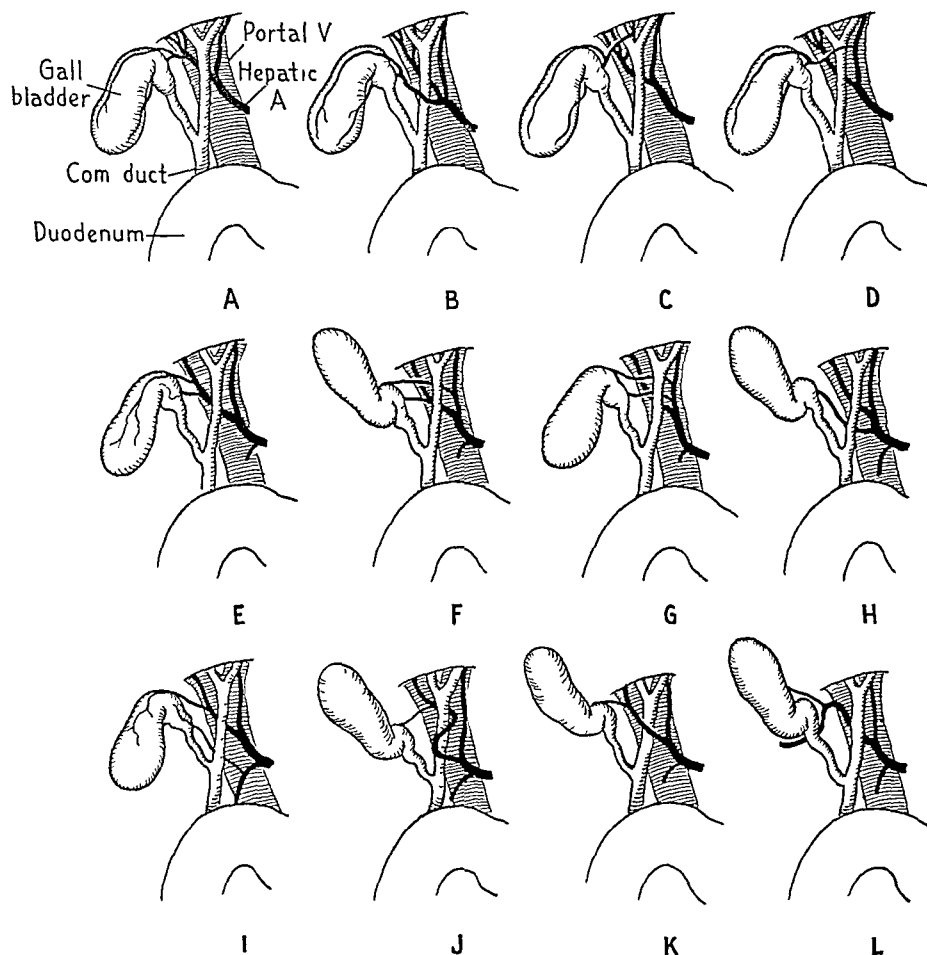


FIG. 6. Shows variations of the single and double cystic arteries. E, F, G, and I show the various types of double cystic arteries. The double cystic artery occurs in 12 to 18 per cent of cases. E shows both cystic arteries off the right hepatic artery. F shows one cystic artery from the right hepatic and one from the left. G shows two cystic arteries from the left hepatic. H shows the cystic artery coming directly from the common hepatic. I illustrates one cystic from the right hepatic and another from the gastroduodenal. The cystic artery may be branched or double. This often gives rise to hemorrhage after the cystic artery has been considered ligated. The cystic artery may be a branch of the pancreatoduodenal artery or even from the superior mesenteric artery.<sup>45</sup> The right hepatic artery may be tortuous and in close relation to the ducts. It may even cover the ducts as shown in Figure 2D and Figure 6J and L making all sorts of fantastic figures. The cystic duct is in close relation to the artery which may be injured during cholecystectomy.

than 2 cm. in length. The circumference of the cystic duct varies, but it is smaller than the hepatic or common bile ducts. This small caliber of the cystic duct is of significance since many accidents of gall-bladder surgery occur about the cystic duct at its site of contact or union with the

that a large duct in this region is more probably not the cystic duct. This junction of the cystic, common and hepatic ducts is the important area. Moreover Calot's triangle is frequently completed by the right hepatic artery instead of the cystic as described by Calot. This variation may

result in ligation of the right hepatic artery for the cystic artery with resulting so-called "liver death." (Fig. 5A to E.)

control it accurately. Instead of this, he clamps wildly and picks up the hepatic duct in the clamp." Attempts to control bleeding

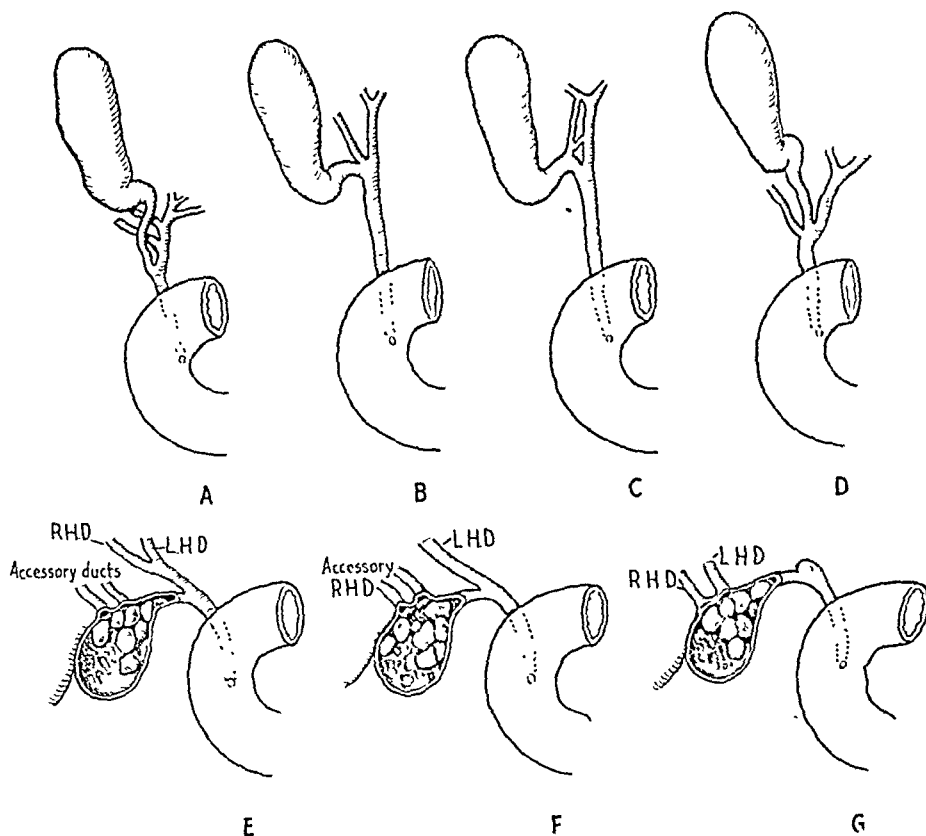
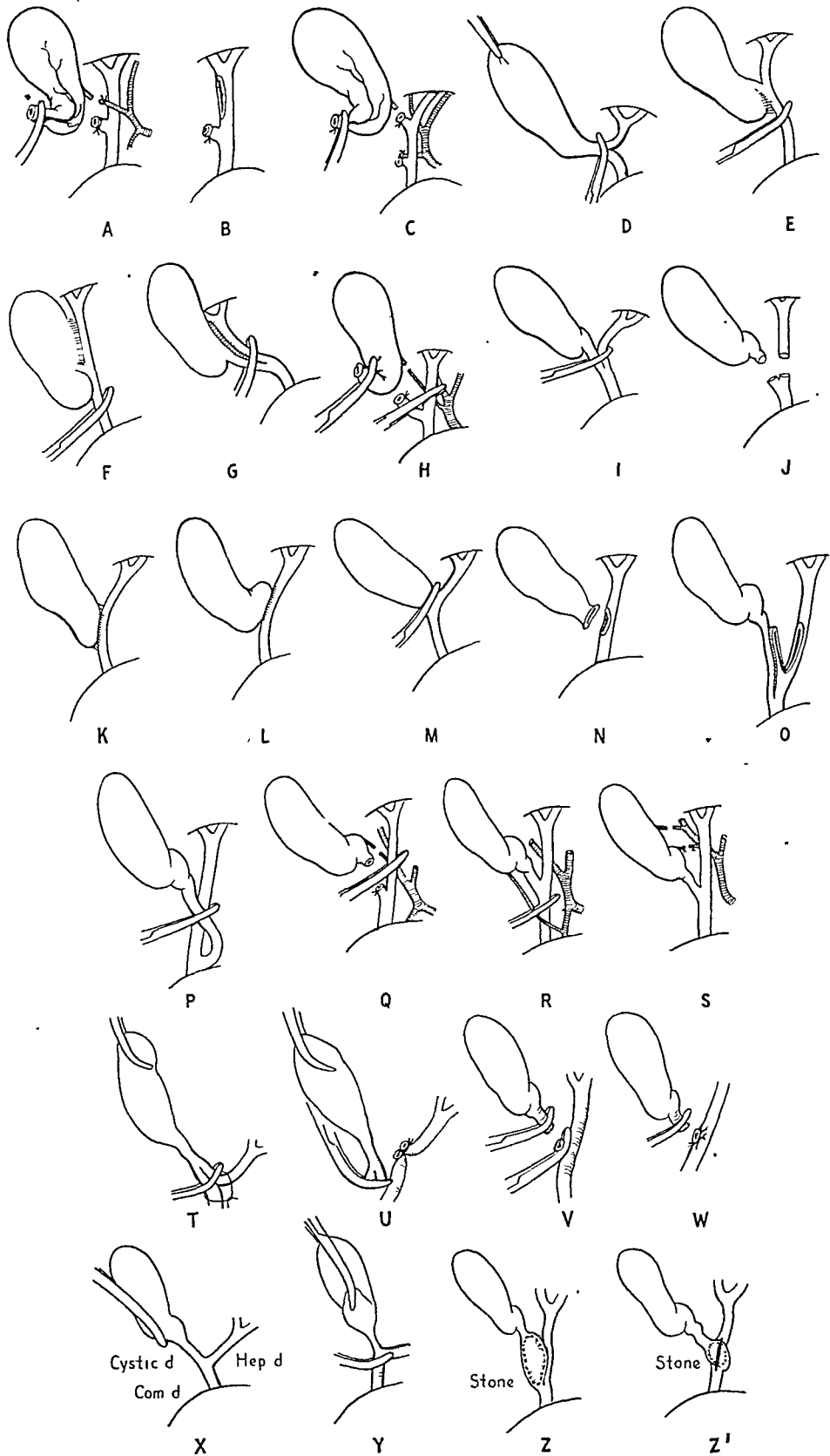


FIG. 7. A to E illustrate the various types of accessory bile ducts which are present in 20 per cent of cases.<sup>43</sup> Leakage of bile from a divided end may be a troublesome or even fatal complication. F shows the right hepatic entering the gallbladder directly and G shows both the right and left hepatic ducts entering the gallbladder. Cholecystectomy from the cystic duct up in F and G would result in a fatality, while attempted cholecystectomy from the fundus down would recognize this anomaly and cholecystostomy could be done.

No one with experience in biliary surgery will deny that this dangerous triangular region which complicates biliary surgery lies at the deepest, most inaccessible point of the operative field. Unexpected hemorrhage from the slipping of a clamp or a tie off the cystic artery in this area is frequently the beginning of a vicious circle. Lahey,<sup>12</sup> speaking of duct injuries says, "They are the result of excitement, I think, the cystic artery gets loose, bleeds into the deep operative field. The inexperienced operator fails to realize that by pinching the hepatic artery with his finger he can stop the bleeding artery, wipe the field dry, find the bleeding vessel, and con-

in this area from a torn or cut cystic artery can produce injury not only to the bile ducts but also to the portal vein, duodenum and even the head of the pancreas.

What is the safest technic for cholecystectomy? There is still difference of opinion among surgeons as to whether the gallbladder should be removed by *starting at the fundus and dissecting downward*, or by *starting at the cystic duct and working upward*. Both methods have their protagonists, but whichever method is chosen, two main factors must be emphasized: (1) It is absolutely essential that a complete isolation of the cystic duct be made before any clamps or ligatures are applied.



(For descriptive legend see opposite page)

(2) The cystic artery and duct must be tied securely (either separately or together).

*In cholecystectomy beginning at the cystic*

always easy, because of the difficulties of exposure mentioned above and because of the great variations in the arrangement

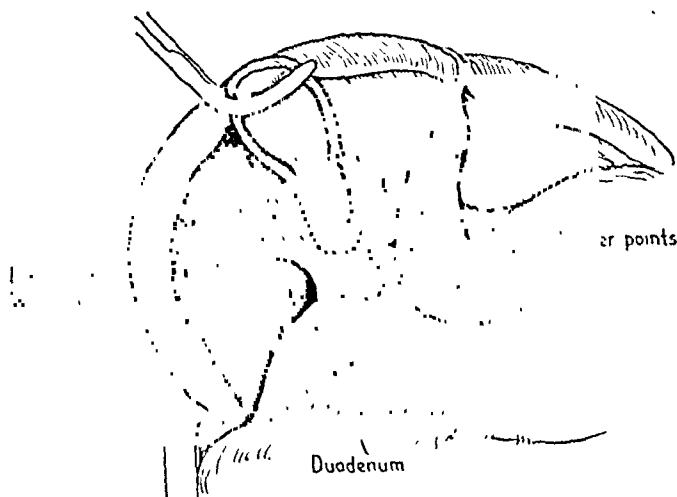


FIG. 9. Shows the method of cholecystectomy from the fundus down. Note the author's method of grasping the fundus so that the tips of the right angle clamp extend beyond the gallbladder. If the tips of the clamp terminate on the gallbladder, the wall of the gallbladder is soon perforated with tearing and leakage of bile. Note the foramen of Winslow and the danger points which are submerged and buried in adhesions. Cholecystectomy from the cystic duct up is more hazardous when the danger points are submerged and they usually are.

duct, the cystic artery and duct are ligated first, this makes cholecystectomy a cinch, for the circulation is controlled from the outset. However, identification and isolation of the cystic artery and duct is not

of the bile ducts and blood vessels. Besides the cystic artery does not always lie to the north of the cystic duct in vermilion color (as illustrated in textbooks of operative surgery) waiting to be ligated. More often

FIG. 8. Illustrates the various mechanisms of operative trauma from A to Z during the performance of cholecystectomy: A, shows ligature of right hepatic artery during the performance of cholecystectomy (after Maingot); B, shows button holing of the common duct (after Maingot); C, shows ligature of right hepatic duct during cholecystectomy (after Maingot); D, clamping of common duct during cholecystectomy (after Kehr); E, the common bile duct has been clamped in mistake for cystic duct. Hartman's pouch overhangs the duct and the gallbladder is adherent and sclerosed (Fig. 2); G, division of common hepatic duct with an adherent cystic duct (after Walton); H, duct and artery clamped by a hemostat following the slipping of the ligature which has been applied to the cystic artery (after Walton); I and J, resection of the junction of cystic and common ducts; K and L, tear or division of the main hepatic duct which might arise in separating the upper side of the pelvis of the gallbladder from the duct (after Thorek); M and N, shows what may happen during cholecystectomy by clamping when the cystic duct is very short. O, shows an injury which may result to the hepatic ducts when the cystic and hepatic ducts run parallel for a long course; P, injury which may arise to the hepatic duct when the cystic duct winds around in front of it; Q, injury resulting to the hepatic duct during effort to catch bleeding cystic artery; R, injury to the common duct during effort to catch anomalous bleeding cystic artery arising from the gastroduodenal; S, hemorrhage which may occur from overlooked second cystic artery; T and U, show semi-diagrammatically how a section of the common and hepatic ducts may be removed by applying the clamp too low after pulling up on the cystic duct (after Lahey) (Figs. 12 and 13); V and W, show diagrammatically how stricture of the duct can result from applying the clamp in cholecystectomy too low. X and Y, show how traction on the gallbladder during cholecystectomy will bring the cystic and common ducts into the same line. The surgeon may, therefore, mistake the common for the cystic and crush it by clamp or ligature (Fig. 15); Z and Z', illustrate how a stone in the cystic duct can occlude the common duct. Removal of such a stone from the cystic duct as illustrated in Z' can injure the underlying or overlying common duct, especially when the stone is located by palpation of the duct and the incision is made directly over the stone.

we encounter a lot of bleeding connecting tissue strands down deep in a dark hole. If the cystic duct which is isolated more

nessed recently in the practice of one of the best surgeons in this country. Under spinal anesthesia, the gallbladder

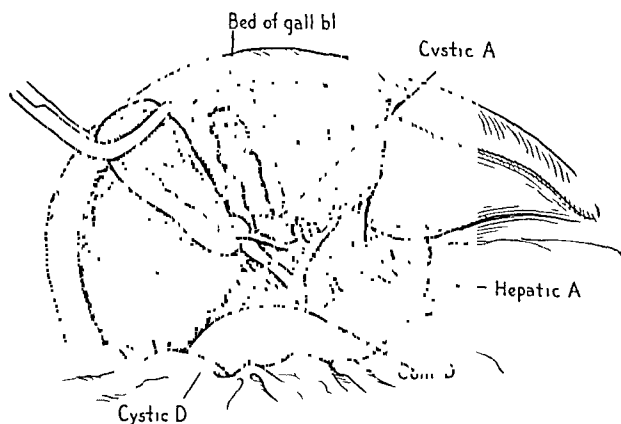


FIG. 10. Illustrates the further progress in removing the gallbladder from the fundus down. The gallbladder is stripped from its avascular cleavage plane in the liver bed leaving a margin of peritoneum with which to cover the raw surface of the liver. Traction on the fundus draws the gallbladder away from the liver bed until the cystic vessels and common duct are reached. In this manner considerable portions of the cystic duct are not left behind and variations of the blood vessels and ducts are more easily recognized. The cystic duct is delivered out of its depth, straightened out and ligated under better exposure and direct vision. (Fig. 10.)

readily than the artery is dissected and cut first, the vessel which is shorter than the duct may tear, retract and bleed freely. Attempts to catch this retracted vessel may lead to the injuries described above. Then again one cystic artery having been secured and ligated, a similar hemorrhage and retraction may occur from a second overlooked cystic artery which is inadvertently cut or torn. This can occur in 12 to 18 per cent of individuals and stampede the operator into efforts of blind control of hemorrhage with its hazards of bile duct injury.

The frequency of ductal and vascular variations in this triangular danger zone emphasizes the hazard of beginning the removal of the gallbladder in this area. Figure 5 shows how easy it is to mistake the right hepatic artery for the cystic and ligate or injure same. That this may occur, it may not be amiss again to relate an incident which the writer wit-



FIG. 11. Photo of the author's dissection showing Hartman's pouch overhanging the common duct with an adherent and sclerosed gallbladder.

and ducts were exposed in a particularly dry, clean field. In plain view, what appeared to be the cystic artery was easily demonstrated, completing the boundary of Calot's triangle. A ligature was passed around this vessel, but fortunately it was not divided since it later proved to be the right hepatic artery and not the cystic. Again, if this can happen to our great surgeons, how much more frequently can this occur in the work of the average surgeon; and most of the cholecystectomies today are performed by the average surgeon.

An adequate incision, proper retraction and a good light are essential for proper exposure and the avoidance of complications. There are few operative fields where roughness and haste are more disastrous. Many technics and tricks have been devised and described toward obtaining good exposure for cholecystectomy. But a good anesthetist is still the best agent of all for the acquisition of a satisfactory

view of the parts concerned in the field of operation. "To see is to save" and anything which cannot be seen especially be certain of the anatomy. Hence the most expert surgeons have been led into entrapments at the triangle which have



FIG. 12.

FIG. 13.

FIG. 14.

FIG. 12. Photo of author's dissection showing how traction on the cystic duct can produce angulation of the common duct.

FIG. 13. Photo of author's dissection showing the mechanism of injury of the common and hepatic ducts by applying the clamp too low after pulling up on the cystic duct.

FIG. 14. Photo of author's dissection showing how stricture of the duct can result from applying the clamp too far down on the cystic duct during cholecystectomy. Part of the wall of the common duct is ligated producing a stricture.

when it is in the operative field is in danger of injury. It seems to me that no one in the light of present information ought to perform cholecystectomy without a thorough knowledge of the parts in the region of the foramen of Winslow. (Fig. 1.) The first step should be to examine the gallbladder and bile ducts and it is good practice to observe the condition of the pancreas at the same time. We are apt, when disease of the gallbladder is manifest, to forget to examine the ducts until a later period of operation, and in consequence we may find ourselves at a disadvantage.

The actual method of removing the gallbladder whether *from the fundus downward* or *from the cystic duct upward* has been a subject of discussion for years. Surgeons beginning at the cystic duct argue that their method is easier since the circulation is controlled at the outset, and in this manner the most difficult part of the operation is accomplished first. However, even with perfect exposure, under spinal anesthesia, one cannot always

led to unhappy experiences. In many instances the neck of the gallbladder and cystic duct are submerged in dense adhesions, and it is not uncommon for the fundus and body of the gallbladder to be well submerged, too. The writer has, therefore, always deemed it safer to begin the excision of the gallbladder at the fundus, since this is usually the least involved by pathological conditions, and work toward the more involved region in the danger zone. (Figs. 9 and 10.) The gallbladder when freed affords an excellent handle to raise the liver, to put the cystic duct on stretch, and to pull forward the deeper lying bile ducts. (Fig. 10.) Hartman has stated that the gallbladder is often the thread of Adriadne which guides us through a labyrinth of adhesions to the position of the common duct. When the gallbladder is dissected free from the liver, the cystic duct and artery are drawn well up into the wound, and there they can be ligated together. Every stroke of the knife or scissors is thus made under direct vision, and in-

flammatory or other bands separated close to the gallbladder. When cutting across the cystic duct care must be taken



FIG. 15. Photo of the author's dissection showing how traction on the gallbladder during cholecystectomy will bring the cystic and common ducts into the same line. It is then possible to mistake the common for the cystic duct and crush it by clamp or ligature.

to avoid too much traction on the gallbladder or Hartman's pouch, so as not to pull up or angulate the common duct. (Fig. 8 T, U, V, X.) In doing cholecystectomy *from the cystic duct up*, the cystic duct having been cut first we are at once deprived of the above advantages; moreover if the accessory ducts as illustrated in Figure 7E, F, and G, are present the operator is in an uncomfortable situation. Therefore, the freeing of the gallbladder from the fundus down is preferred by the writer because variations can be noted first and the cystic duct can be freed more simply in this direction and it leads to the common duct. If the gallbladder is large, tense, or obstructs the approach to Calot's triangle, it can be partly emptied by aspiration. Long remnants of the cystic duct are thus not left behind with the possible sequelae of biliary dyskinesia.<sup>14</sup> Any vessel present can be clamped on or close to the gallbladder or cystic duct as encountered, and thus there is less danger of injury

to the right hepatic artery or ducts. The great variations in the arrangement of the biliary ducts and hepatic and cystic arteries as illustrated occur in 70 per cent of cases.<sup>13</sup> Since it is unsafe to anticipate any regular or normal arrangement of these structures it is highly important in every case positively to identify the cystic duct and artery, regardless of their situation before they are cut or ligated. This is often difficult. If the duct is isolated and divided before the cystic artery, the cystic artery which is shorter may tear and retract with sharp hemorrhage deep in the wound. The relationship of the artery to the duct is almost like a bowstring to a bow, since it is shorter than the duct and lies on a plane closer to the liver. The cystic artery usually passes behind and not along the cystic duct to the gallbladder. The order must then be reversed and the cystic artery ligated first before cutting the cystic duct to prevent trouble. If one can localize and be certain of the position of each of these structures, there is certainly no objection to the method from the cystic duct up. Judd's method<sup>15</sup> of carefully catching the cystic duct and artery, exposing them together and separating them from the notch of the liver while sealed in their connective tissues and ligating them together may be tried. However, so many variations and adhesions are so often found in this inaccessible area that the inexperienced operator may mistake the common for the cystic and even the hepatic duct may be completely severed or a section of it removed. This accident can be avoided if the fundus and neck of the gallbladder are dissected carefully down to the cystic duct and the cystic duct followed to its junction with the common before it is ligated and divided (see Fig. 16). The cystic duct should not be removed flush with the common hepatic duct. (Fig. 8v.) It is safer to leave enough of the cystic duct to minimize the danger of later cicatricial contraction of the common duct. In all

cases of doubt it is much wiser to leave a small portion of the gallbladder than to run the risk of injuring the common or hepatic duct. Besides since there may be two cystic arteries, dissection from the fundus down would encounter and secure these vessels during dissection either on the wall of the gallbladder or behind the cystic duct. The contents are thus noted, stones can be felt and if a stone is impacted in the ampulla or cystic duct it can be pushed back into the gallbladder, giving easier access to and localization of the duct. The peritoneal coat is stripped off from the gallbladder leaving a margin of about three-fourths of an inch on either side and by blunt dissection the gallbladder is stripped from its avascular cleavage plane between the gallbladder and liver bed. (Fig. 10.) Traction on the fundus draws the gallbladder away from the liver bed until the cystic vessels and ducts are reached. (Fig. 10.) In this manner considerable portions of the cystic duct are not left behind and anomalies of the blood vessels and biliary ducts are more easily recognized. The cystic duct is delivered out of its depth, straightened out and ligated under better exposure and direct vision. Good exposure is often difficult if not impossible by any other method in this danger zone. The vessels when exposed in this manner usually lie to the inner and upper aspect of the neck of the gallbladder and cystic duct and can be easily clamped and ligated. Nothing should be clamped, cut or ligated unless positively identified. Constant visualization is essential to avoid injury to the ducts. Blind and careless application of a clamp to control hemorrhage from the cystic vessels is unpardonable. The cystic duct is then visualized and cut between clamps. If the dissection is begun at the neck of the gallbladder or at the junction of the cystic and common ducts, it may be almost impossible to define and expose these structures clearly because of the deformity, thickening and contracture produced in

this zone by inflammation. (Fig. 9.) Ligation of the cystic artery at this point is likewise fraught with great danger since



FIG. 16. Photo of the author's dissection of the junction of the cystic and common ducts. Note the usual length of the cystic duct. Note that the cystic duct is of smaller caliber than the common and enters same at right angles.

it can be confused with the right hepatic artery. After transfixion and double ligation of the cystic duct with chromic catgut, the bed of the gallbladder is sutured with fine plain catgut on an A-traumatic needle thus closing the raw surface of the gallbladder bed. Accessory bile ducts and variations of the normal bile ducts are so numerous that the writer always employs drainage following cholecystectomy. No harm is done by leaving a small Penrose drain in for several days and occasionally it saves a life. The terse saying of the late John B. Deaver is sufficiently emphatic in this respect. He stated that in a patient dying of bile peritonitis following cholecystectomy where no drainage had been employed, he would have inscribed on the tombstone, "Died following cholecystectomy without drainage."

Only a proper definition of the parts at operation combined with a detailed knowledge of the anatomy, particularly of the ductal and vascular structures, will prevent errors. Skill in cholecystectomy cannot be acquired in either ten easy lessons or five hard ones. The pitfalls of gallbladder surgery can be avoided



only through a detailed familiarity with the lay of the land coupled with experience and the ability to anticipate trouble.

### SUMMARY

The problems of cholecystectomy are discussed. The important variations and anomalies of the bile ducts and blood vessels are demonstrated and their surgical significance in cholecystectomy emphasized. With the increased number of cholecystectomies there has been an increased incidence of bile duct injuries. Since prevention of injury is of paramount importance, a thorough familiarity with every possible variation in the biliary tract is mandatory.

Any surgeon performing cholecystectomy must be qualified to recognize and deal with safely any pathological conditions involving the extrahepatic ducts as well. The extrahepatic ducts and their related blood vessels are, therefore, demonstrated by diagrams and photographs of the author's dissections. The right hepatic artery instead of the cystic not infrequently forms the base of Calot's triangle; it can, therefore, be mistaken for the cystic artery and ligated accidentally with death of the patient.

The author prefers cholecystectomy *from the fundus down* and believes this method safer than cholecystectomy *from the cystic duct up*. The reasons for this are given. Cholecystectomy should always be accompanied by drainage.

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FUNCTIONAL stenosis of the lower end of the esophagus is usually successfully treated by *dilatation methods*. An air-inflated rubber bag is commonly used. Mechanical digital dilatation through an incision in the stomach may be indicated in rare cases.

From "Operations of General Surgery" by Thomas G. Orr (W. B. Saunders Company).

# SHAFT FRACTURE IMMOBILIZATION WITHOUT PLASTER

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THE principal inadequacies of the usual method of treating fractures of the shaft are: (1) Necessity for

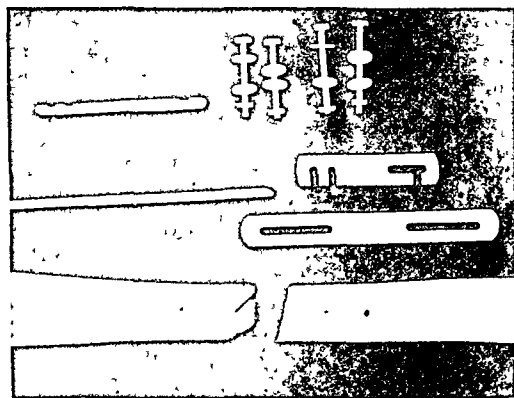


FIG. 1. Apparatus used for fixation of shaft fractures, four bolts with washers and a pair of slotted plates; front and side views.

plaster immobilization with resultant ill effects upon adjacent joints. Such effects are occasionally permanent or entail a long period of inactive convalescence. (2) Uncertainty of accurate reduction of the fracture. The attention of the general surgeon is directed to a means of obviating these defects by use of a modified bone plate assembly developed by the author.

Each assembly consists of two plates and four bolts made of Vitallium. One plate, called the front plate, is made with two slots in place of the series of holes used in the Sherman or Lane plate. The second plate, known as the back plate, is shorter and has a T-slot at one end and two comb-like openings at the other end. (Fig. 1.)

## OPERATIVE PROCEDURES

The detail of using the assembly consists of first making an incision at the site of the fracture, and then aligning the fracture in anatomical reduction. While this is held in position by an assistant, the front plate

is placed across the side of the fracture nearest the operator, and with a gimlet, four bone marks are made, two through each slot. The two outer marks should be as far away from the fracture site as the plate will permit, and the two inner bolts as close together as the plate will permit. Extreme accuracy is not vital as long as the four marks are in the same line. The plate is then lifted away from the bone. Each fractured fragment is lifted out of the tissue, and by means of the drill, either electric or hand, four holes are made, two in each fragment, running through both cortices. The proper length bolts are then inserted from the *opposite* side and the fragments placed back into anatomical position within the soft tissue. This leaves the fracture lying in anatomically correct position with four bolts projecting toward the operator. The slotted plate is then simply placed over the four bolts. Washers are slipped on, and the nuts are loosely fastened to the four bolts. The assistant now impacts the fracture. The slotted arrangement of the plate permits the forceable impaction of the fracture ends and maintains the anatomical alignment. The two outer bolts are then securely tightened, but the two inner bolts are left loose until the back plate is slipped into position under the bolt heads. (Figs. 2 and 3.)

When the back plate is inserted over the two inner bolts, these two are tightened with the wrench, and the immobilization is complete. The construction of the back plate, as can be seen from the drawing, permits compensation for inaccuracies in the position of the bolt holes. A simple sterile dressing is used over the wound.

Special attention is called to the necessity, in the operating technic, of entering

the four bolts from the side of the bone opposite the operator and of using the front plate on the side near the operator.

non-union of the middle of the tibia, the patient was made ambulatory with the aid of crutches on the fifth day postoperatively.

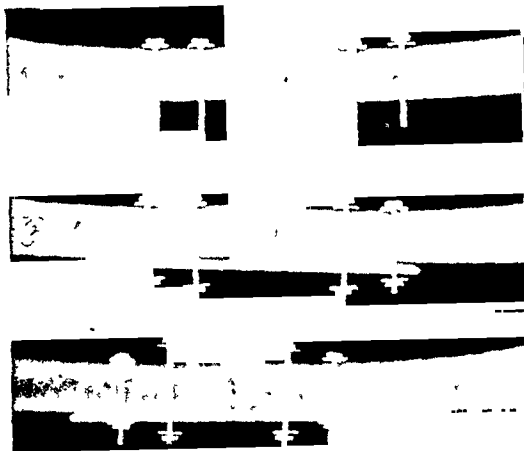


FIG. 2. 1, bolts in position through drilled holes; 2, slotted plate in position before fracture is impacted; 3, impacted fracture with two outer bolts tightened.

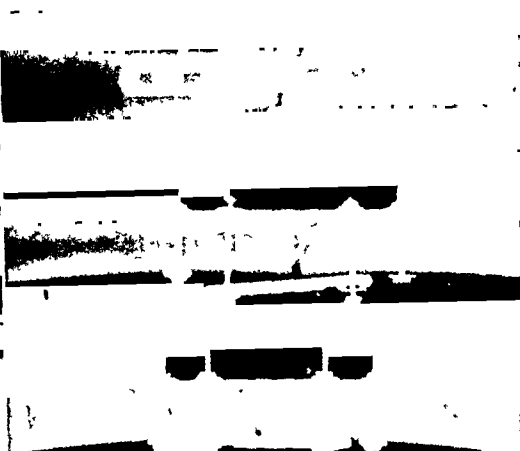


FIG. 3. 4, Other view of slotted plate in position with outer bolts tightened; 5, smaller plate slipped into position over two inner bolts; 6, thorough immobilization with all bolts fastened securely, both plates in position and fracture impacted.

It will be obvious also that a plate assembly of different size is required for each type of bone to which this method is applied. Bolts of adequate length must also be available. The excess length may be removed by means of cutting pliers with a high leverage factor.

#### CASE REPORTS

In a patient with a fracture of the femur to which this procedure was recently applied, it was noticed that within twenty-four hours following operation the patient actively moved the limb in bed. He was able to flex the hip and knee about 20 degrees and was able to abduct and adduct the extremity with practically no distress. In a second case, involving

#### SUMMARY

The chief advantages of this method are the ability to impact the fracture before the bolts are tightened, and the fact that the fixation\* is so rigid that plaster immobilization is not necessary. Experiments on the cadaver and in the operating room prove the immobilization so rigid that manipulation of the extremities fails to disrupt the fracture reduction and impaction. Because of this, plaster of Paris need not be used. The joints above and below the fracture site are left free for active motion.

\* These Vitallium plates are manufactured by the Austenal Company of New York City.



# REFRIGERATION ANESTHESIA

## WITH SPECIAL REFERENCE TO TREATMENT OF A SEVERELY DAMAGED EXTREMITY COMPLICATED BY VISCERAL INJURY

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THE ability of lowered temperature to produce anesthesia has been known for many years and its application to surgery has been demonstrated by the work of Allen.<sup>1</sup> The advantages of this type of anesthesia are particularly apparent in the following types of cases:

*First:* For chronic circulatory failures of the extremities, such as, gangrene due to arteriosclerosis, diabetes and Berger's disease, etc.<sup>2,3,4</sup>

*Second:* In cases of acute circulatory disturbances, such as injury to major arteries or embolus, refrigeration anesthesia has given the extremity time to develop collateral circulation thus permitting a more distal amputation than might appear necessary on first examination.<sup>5,6</sup>

*Third:* In severe infections the local process can be placed in "suspended animation" often giving the surgeon needed time to build up the patient for the operative procedure. The therapeutic measures in the hands of the surgeons, such as repeated transfusions, sulfa drugs, penicillin, etc., frequently require a longer time than one would choose to wait when the infected extremity is kept at body temperature.<sup>7</sup>

*Fourth:* Another undoubted value of this type of anesthesia is the control of traumatic shock. In these days of world-wide conflict and speeded up production, the treatment of shock has come to assume a major rôle. The value of plasma, etc., is certainly not to be reduced in any degree; however, the addition of refrigeration anesthesia, whenever feasible, seems to be a definite adjunct in the armamentarium of a surgeon.<sup>8</sup>

The author wishes to present briefly eight amputations performed under refrigeration anesthesia. The ninth case is

presented in detail as it appears to demonstrate the particular value of refrigeration anesthesia in certain severe traumatic cases.

Case number one is of particular interest as the child fell on a bottle causing severe laceration of the popliteal space including the popliteal artery and vein. There was gangrene and infection of the foot. Prior to application of ice it appeared as though femoral amputation would be necessary. However, following refrigeration a definite demarcation developed above the ankle, thus permitting an amputation approximately five inches below the knee.

In Case number two the patient was discharged from the hospital with the stump healed and he expired at home.

In Case number four the patient had severe heart disease with gangrene of toes due to embolus. This patient was moribund and had another type of anesthesia been necessary, no amputation would have been attempted. He expired two days after the operation.

In Case number eight the patient had a 4 plus Wassermann of spinal fluid and blood and aortitis. The severe Charcot's joint had become infected and it was believed that he would not survive a general anesthesia. The patient withstood the refrigeration anesthesia and amputation very well; however, the stump became infected. It would appear there are two factors which may have caused this infection: (1) the fact that there seems to be some delay in healing, and (2) the amputation was done too close to the edematous tissue of the Charcot joint.

Cases three, five, six and seven are self-explanatory from the table.

TABLE I

Name	Age	Sex	Race	Diagnosis	Site of Amputation	Comments
1. D. P. ....	9	F	Wh.	Traumatic severance of popliteal artery with gangrene and infection of foot	Five inches below knee	Healed
2. A. P. G. .	76	M	Wh.	Arteriosclerotic heart disease with gangrene of foot	Mid thigh	Healed; expired after leaving hospital
3. J. B. W. . .	70	M	Wh.	Embolus with gangrene	Mid thigh	Healed
4. A. S. . . .	54	M	Wh.	Embolus and gangrene with infection; patient moribund	Mid thigh	Expired two days
5. R. B. J. . . .	80	F	Col.	Arteriosclerotic gangrene	Mid thigh	Healed
6. M. H. . . . .	67	F	Wh.	Diabetic gangrene	Mid thigh	Healed
7. N. C. . . . .	74	F	Wh.	Arteriosclerotic gangrene	Mid tibia	Healed with one eschar 2 cm. in diameter
8. O. S. . . . .	57	M	Wh.	Infected Charcot's knee with aortitis	Mid thigh	Stump infected
9. R. H. . . . .	31	M	Wh.	Dislocation of knee with macerated right tibia; fractured pelvis; ruptured bladder and urethra	Mid thigh	Healed

Mortality 2—equals 22 per cent including one patient who died at home after discharge from hospital.

Mortality in hospital—11 per cent.

Cases one to four from service of Hugh A. Bailey, M.D.

Cases five and six from service of J. E. Cannaday, M.D.

#### CASE 9, PRESENTED IN DETAIL

A white male, age thirty-one, a coal miner, was run over at the right upper tibia by a loaded car. It dragged him about thirty feet and crushed his pelvis. This happened at approximately 2:30 P.M. and the patient reached the hospital at 6:00 P.M. On admission he was in severe shock; blood pressure could not be obtained and his pulse was thready and hardly palpable. The upper third of the right tibia was completely macerated with extensive damage to the muscles and skin up to the knee and the right knee was dislocated. Pressure on the pelvis produced grating. Patient was immediately placed in shock position and 500 cc. of plasma started. At 6:30 P.M. the blood pressure rose to 76/40. Adrenal cortex 5 cc. was given intravenously. At this time an attempt was made to catheterize the patient and only pure blood was obtained. The second 500 cc. of plasma was begun. At 10 o'clock P.M., the blood pressure had risen to 100/60. The patient was taken to the x-ray department where an intravenous pyelogram was made. This showed complete rupture of membranous urethra and enteroperitoneal rupture of the bladder. Other

x-rays taken at this time showed comminuted fractures of the sacrum, also both pubis and ischium with slight overriding of the fragments of the ischium, right knee dislocated and right tibia and fibula showed a splintered fracture of the upper one-half of the shaft. The patient was treated further for shock by starting the third 500 cc. of plasma and by approximately 12 o'clock midnight, the blood pressure had risen to 120/60.

At this time the patient was taken to the operating room and the rupture in the bladder and urethra were repaired through a suprapubic incision. Following this procedure, the patient's blood pressure was 95/40. It was rather obvious that there would be no hope of saving the right leg below the knee. At the time of repair of the bladder and urethra, serious consideration was given to the possibility of performing mid-thigh amputation; however, it was decided to encase the macerated leg in ice with a tourniquet above the knee and wait for further development. Immediately on placing the patient in bed 500 cc. of whole blood was started. Blood pressure taken every thirty minutes showed a gradual rise.

At approximately thirty-six hours later, the blood pressure had risen to 140/90 and the patient's general condition was greatly improved. The right leg was still encased in ice. The rubber sheet technic as demonstrated by Crossman, Allen et al.<sup>9</sup> was followed. At this time a decision was made to perform mid-thigh amputation. Therefore, a second high thigh tourniquet was applied and the ice was extended up to the groin. Three hours later, that is, approximately thirty-nine hours since the application of ice, the patient was moved to the operating room in bed. It was believed that it would be inadvisable to move the patient out of the bed due to the fact that he had severe fractures of the pelvis. Mid-thigh amputation was done with the patient in bed. The usual technic of Kirk was employed. The patient experienced pain when the sciatic nerve was cut, otherwise he appeared to have no particular discomfort. His blood pressure, pulse and respiration did not show any change during or after the operation. The muscles and skin were closed over the stump with cotton sutures, the complete operation requiring approximately one hour. Ice bags were applied to the stump. These were removed one at a time within the next five days. On returning to his room, an overhead frame was applied with pelvic sling for treatment of his fractured pelvis.

Postoperatively, the patient was given repeated small transfusions. He ran a low-grade fever and for a time complained of pain in the abdomen. This was probably due to the cystotomy and fractured pelvis. The stump of the right thigh healed per primum and three weeks later the patient became afebrile. Five weeks later his suprapubic cystotomy was healed. The pelvic sling was left on this patient for seven weeks at which time x-ray examination showed healing in satisfactory position and he was fitted with a lumbosacral corset and discharged from the hospital.

#### SUMMARY

In the care of the usual types of severe injuries to the extremities one is able to proceed with definitive therapy following the treatment of shock which is frequently present. There are, however, some cases of injuries to the extremity complicated by visceral damage. Before the advent of refrigeration anesthesia, the surgeon was left in a quandary trying to decide what should be done first.

It is generally agreed that visceral damage must receive immediate treatment and when an attempt is made to carry out major amputations at the same time, the outcome is usually fatal. In the opinion of the author, the use of refrigeration anesthesia seems to make it possible to delay the treatment of the extremity without harmful effect to the patient.

When the decision is reached regarding the necessity of sacrificing the extremity a tourniquet must be applied and amputation must be done above this level, thus several inches more of the extremity must be lost. The tourniquet appears necessary due to the rather considerable oozing that one sees in severely macerated extremities with comminuted fractures even after the major vessels have been ligated. It is rather difficult to reach a definite decision to amputate and then continue to wait. However, in the case presented, packing the injured leg in ice and waiting thirty-nine hours appears to have been of definite aid to the patient. Dissection of the amputated specimens have shown some soft clot formation. One naturally wonders if this type of anesthesia might not be used also for short reconstructive surgeries of the extremities when other anesthetics are contraindicated.

The author wishes to express his appreciation to Dr. J. E. Cannaday and Dr. Hugh A. Bailey for permission to include their cases in this report. The urological treatments were rendered by Dr. G. G. Irwin.

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# METHOD OF REMOVING T-TUBES FROM THE COMMON BILE DUCT

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THE removal of T-tubes from the common bile duct is frequently associated with temerity on the part of the person removing the tube. Most surgeons pull the tube out briskly when they have decided that it has served its usefulness. This practice was followed by us until a disastrous experience altered our method.

T-tube is usually found to have increased an inch or more. The abdominal wall is no longer depressed and the T-tube is

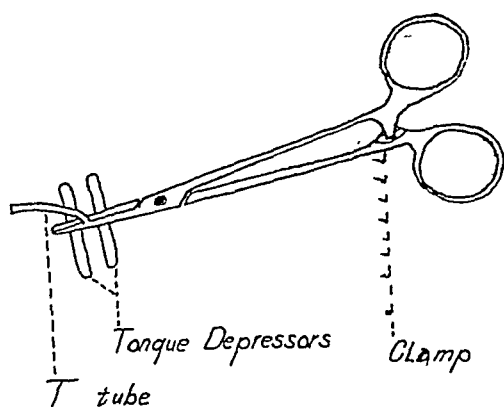


FIG. 1. Showing application of clamp over two tongue depressors on the anterior abdominal wall.

of the person removing the tube. Most surgeons pull the tube out briskly when they have decided that it has served its usefulness. This practice was followed by us until a disastrous experience altered our method.

At present we follow a routine which may be interpreted by others as excessive labor for a simple procedure. However, since the adoption of this routine we have encountered no difficulties. For the past two years we have removed T-tubes from the common duct in the following manner:

During morning rounds two tongue depressors are placed on either side of the tube to be removed. With slight pressure on these blades the abdominal wall is depressed. The T-tube is then clamped with a Kelly clamp close to the tongue blades. (Fig. 1 and 2.) When evening rounds occur, the visible portion of the

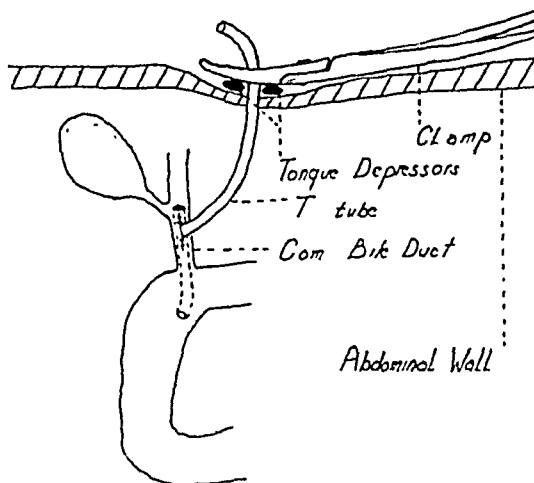


FIG. 2. Cross section view showing T-tube under tension due to spring-like action of the abdominal wall.

out of the common duct and is in the peritoneal cavity. The tube is then painlessly pulled through the skin orifice.

The dynamics by which this has occurred resolves about: (1) The resiliency of the abdominal wall which acts like a spring as it pulls the T-tube out of the duct gradually; (2) where the spring-like mechanism appears to be inadequate, as in thin-walled individuals, the abdominal respiratory excursions are sufficient for extirpating the tube from the duct. On several occasions we have encouraged an apprehensive patient to breathe with a sand bag on the chest. This accelerates diaphragmatic breathing with a resultant increase in intra-abdominal pressure. This pressure causes an increase in the antero-posterior diameter of the peritoneal cavity.

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An increase in diameter such as this pushing against a fixed point (the clamp) pulls the tube out of its surroundings. (3) More recently we have simply requested the patient to sit up in bed after the application of the clamp and the tube is removed immediately. The removal is accomplished through the contraction of the rectus muscle which increases the width of the abdominal wall one, two or

more inches depending upon the muscular development of the individual.

This procedure has been painless to the patient and very convenient to the surgeon, especially in the management of a timid patient fearful of the removal of the tube. It is hoped that others will employ this method and find it as convenient for themselves as it is for us; even as it is painless to the patient.



METASTATIC abscesses and metastatic tumors may spread to areas that do not seem to be in line of direct spread from their primary focus. There is even a regularity of distribution of these paradoxical metastases, according to Batson.

From "Metastases Medical and Surgical" by Malford W. Thewlis (Charlotte Medical Press).

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# Case Reports

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## CECOCOLIC INTUSSUSCEPTION IN THE ADULT

### CASE REPORT

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**I**NTUSSUSCEPTION in the adult is an uncommon lesion, but when it does occur, unlike the situation in children, there is usually a definite inciting factor, such as a polyp or polypoid tumor. In the case reported herein, the wide mesentery of the terminal ileum, cecum, and ascending colon was the predisposing factor which made the intussusception possible. At the time of the first laparotomy an inciting factor was expected and careful search was made for it. A decision could not be reached at this time regarding the nature of the localized tumefaction of the lateral wall of the cecum, but re-examination one month later confirmed the impression that the lesion was secondary rather than primary. Re-examination also established the efficacy of a series of interrupted seromuscular sutures in the fixation of the bowel to the posterior abdominal wall. Fixation at this time had occurred over a wide area and was very secure.

In retrospect it is quite possible that intussusception of varying degree had occurred repeatedly, only to reduce itself spontaneously. In confirmation of this one may point out that the symptoms had begun thirteen days prior to operation, but had varied rather than increased in severity and that the mass had been observed to disappear and reappear several times in the last few days before operation. Furthermore, at the time of operation the distal ten inches of ileum, though not at the time involved in the intussusception,

were edematous and indurated as if recently so involved.

### CASE REPORTS

The patient was a twenty-six year old white soldier who, prior to induction twenty-eight months before onset of present illness, had been a farmer in the middle west. His family history was irrelevant. He had had the usual childhood illnesses. In 1925, at seven years of age he had a tonsillectomy, and in 1930, an appendectomy. In 1937, he had gonorrhea which was promptly treated and was thereafter asymptomatic until October, 1941, when he had a urethral discharge for one month.

This patient entered a General Hospital on October 20, 1943, complaining of pain in the right flank of three months' duration, and frequency and nocturia of eighteen months' duration. The pain occurred infrequently, usually lasted fifteen to twenty minutes, was specifically located in the right costovertebral angle, and did not radiate. It usually occurred after exertion, especially after lifting heavy weights.

Complete investigation in October, 1943, revealed a somewhat enlarged soft prostate which on massage yielded an exudate containing many pus cells, some of them in clumps. Excretory and retrograde pyelograms revealed an extrarenal pelvis on both sides, some pyelectasia, which was more marked on the left, and blunting of the calices, which was interpreted as a mild bilateral hydronephrosis. The right kidney was moderately nephroptotic.

The patient was transferred to the Zone of Interior and admitted to the hospital on the Genito-Urinary Section on November 29, 1943. During transit his symptoms had subsided. Retrograde pyelograms on December 3, 1943, were interpreted as normal;

each pelvis revealed only developmental anomalies. The prostate had returned to normal. The patient was about to be discharged to

nourished young male with sallow complexion. His skin and mucous membranes were somewhat dry. Other positive findings were limited



FIG. 1. X-ray appearance of colon eighteen hours after ingestion of barium demonstrating intussusceptum.



FIG. 2. X-ray appearance of intussusceptum as outlined by retrograde barium enema filling.

duty when he began to complain of a new group of symptoms.

On December 5, 1943, the patient began to have moderately severe intermittent cramp-like pain at various points within a twelve inch circle about the umbilicus. This pain recurred repeatedly throughout the day and night and interfered with sleep. It was aggravated by imbibing fluids, especially if cold, and by ingesting foods, so that the patient gradually lost his appetite and began to lose weight. His bowels continued to function quite regularly, without noticeable effect on the pain. Five days after onset of this pain, the patient began to vomit once daily after supper. This vomiting was not of the cumulative type.

On December 14, 1943, the patient was examined by a general surgical consultant and a mass the size of a small grapefruit was found in the right upper quadrant of the abdomen, attended by visible and grossly audible peristalsis. The patient was transferred to the General Surgical Section.

The patient was a thin, chronically mal-

to the abdomen. The latter was scaphoid. Neither liver nor spleen were palpable. There was a well healed McBurney scar. In the right upper quadrant, more specifically the right upper para-umbilical quadrant, there was a well defined but rather soft, non-tender mass the size of a small grapefruit. There were visible and grossly audible peristaltic waves in this region which seemed to lift the mass into greater prominence during various periods of observation. Rectal examination was negative.

The patient's course thus far had been afebrile. His laboratory data revealed no striking abnormality. Repeated urinalyses had been normal. Red blood count was 4.09 million, white blood count 7,100; hemoglobin 12.5 Gm. Sahli. The differential revealed 56 per cent neutrophils, and 44 per cent lymphocytes. Non-protein nitrogen was 31 mg. per cent, chlorides 406 mg. per cent, icteric index 8.1, plasma protein 6.9 Gm. per cent.

Proceeding on the assumption that the patient had a partial intestinal obstruction,

the significance of the mass was not at once realized. A scout film revealed no diagnostic gas shadows. It was therefore decided to

intussusceptum and the distal ten inches of ileum, which was not found intussuscepted at the time of operation, were edematous and



FIG. 3. The tumor mass lies to the right of the upper index finger, the terminal ileum to the left, demonstrating that the cecum and ascending colon have intussuscepted.

fluoroscope the patient and study the progress of a small amount of thin barium suspension administered by mouth. Barium passed normally through the stomach, duodenum, and small bowel, revealing no abnormality except for an inverted U-loop of the first portion of the duodenum. A film taken eighteen hours after ingestion of barium revealed the barium stretching out in large thin circles in the region of the transverse colon just distal to the hepatic flexure. Distal to this the colon, which contained some barium, became abruptly contracted. (Fig. 1.)

It was now quite obvious that the patient was suffering from obstruction of the large intestine, almost certainly caused by intussusception. It was also clear that the obstruction was only partial and that strangulation had not yet occurred. Because the patient was not acutely ill, a barium enema was done while preparations were being made for operation. Meanwhile he was also given parenteral fluids, including plasma. The barium enema confirmed the diagnosis of intussusception. (Fig. 2.)

On December 18, 1943, operation was done under intratracheal gas oxygen ether. There was a little clear, straw colored fluid in the peritoneal cavity. Exploration revealed that the cecum and ascending colon had intussuscepted into the proximal third of the transverse colon. (Fig. 3.) Reduction of the intussusception was fairly easy. There was no evidence of acute strangulation, but the

chronically thickened, as if they had been recently involved in an even more extensive process. After reduction the ascending colon,



FIG. 4. After reduction of intussusception demonstrating the mobility of ascending colon and cecum. The indurated lateral wall of cecum is held upward on the left.

cecum, and distal twelve inches of ileum were found to be free on a fairly wide mesentery. On the lateral wall of the cecum there was a knob-like tumor mass 3 cm. in diameter and 0.75 cm. in thickness which had apparently formed the head of the intussusception. Its internal surface felt smooth and its borders gradually blended with the cecal wall. (Fig. 4.) It could not be determined whether this tumor mass was merely due to chronic induration from repeated intussusception, or to an early neoplasm, so a side-to-side ileotransverse colostomy was done in anticipation of possible resection later. A large soft lymph node was removed from the transverse mesocolon. Before closure the ascending colon and cecum were

fixed to the peritoneum of the lateral gutter with a series of sutures in order to prevent a recurrence of the intussusception.

The patient made an uneventful recovery. He was ambulatory in three weeks. The pathological report classified the node removed from the transverse mesocolon inflammatory in nature. A barium enema was done on January 10, 1944, but the cecum could not be well enough demonstrated to rule out an early sessile tumor. As originally planned at the time of the first operation an exploratory laparotomy was done on January 14, 1944. The cecum was examined by palpation and direct vision and the localized tumefaction of its lateral wall, as well as the edema and induration of the terminal ileum, cecum and ascending colon had completely disappeared. Moreover, the cecum and ascending colon were firmly adherent to the lateral gutter.

The patient again made an uneventful recovery. Visceral functions remained normal, the patient gained weight, suffered no pain, and two months later, was ready for return to full duty.

#### SUMMARY

1. The case history of a cecocolic intussusception in a young adult has been presented.
2. The lesion caused neither complete intestinal obstruction nor strangulation.
3. A predisposing factor, the presence of a wide mesentery, was found at operation, but there was no inciting factor.
4. X-ray films demonstrating the lesion after both oral and rectal administration of barium have been reproduced.
5. The measures employed to prevent recurrence of the lesion have been outlined.

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# SIMULTANEOUS PRIMARY CARCINOMAS OF THE STOMACH AND SIGMOID

## CASE REPORT

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AND

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IN 1937, Pemberton and Waugh<sup>4</sup> reported a unique case in which two primary carcinomas appeared simultaneously, one in the sigmoid flexure and the other in the stomach of the same individual. Both of the lesions were amenable to surgical treatment. It was pointed out that the finding of multiple primary carcinomas in the same individual was becoming of increasingly common occurrence. The incidence of cases in which simultaneous, multiple primary malignant growths have appeared, as revealed in published reports, varies from 0.6 per cent to 7.8 per cent among all cases of malignancy. Review of the literature, in 1937, revealed but thirty-four reports of instances in which independent carcinomas involved the colon and stomach of the same patient; the case which was reported then brought the total to thirty-five. The sigmoid flexure was said to be involved in only four of the cases reviewed.

The following case, encountered recently at the Mayo Clinic, is similar to the case reported in 1937 in that it presented the rare combination of two clinically demonstrable, separate and distinct carcinomas, both amenable to surgical removal, occurring simultaneously in the sigmoid portion of the colon and in the stomach of the same individual.

## CASE REPORT

A man, sixty-eight years of age, came to the Mayo Clinic November 18, 1943, complaining of gaseous indigestion and a sensation of fullness after meals. About three months before his admission, he had begun to notice bloating, fullness and gaseous eructations occurring

immediately after eating, as well as anorexia and, at times, slight nausea. Approximately one month later, the patient had begun to experience intermittent epigastric pain which had occurred about two hours after eating and which had not been accompanied by nausea nor emesis. The pain was not relieved by taking of food, but occasionally was relieved by taking alkali. The man had lost six pounds (about 3 kg.) during the two months before his admission.

Five years prior to onset of the present symptoms, the patient had noted epigastric pain which occurred when his stomach was empty, accompanied by slight nausea, but relieved by taking of food. This distress had been noted intermittently for three or four months; then it had disappeared and had not recurred until onset of the present symptoms. Two years before his present illness, the patient had noted black stools for three or four days and, for the past six or seven years, occasionally he had noted the passage of small amounts of bright blood from the rectum.

In 1941, active pulmonary tuberculosis had been diagnosed elsewhere, and a chronic, hacking cough had persisted, with occasional intermittent thoracic pain. The patient's past history was otherwise negative. He had not undergone any surgical operation.

Examination at the clinic revealed a pale, thin, elderly man whose weight was about twenty-two pounds (about ten kg.) less than the so-called normal for his age and height. Râles and increased breath sounds were heard in the upper left portion of the thorax. The abdomen was negative to examination except that bilateral inguinal hernias were found. Digital examination of the rectum revealed a small, firm mass, which was not tender, high on the posterior wall. Urinalysis and examination of the blood did not reveal any abnormality beyond slight secondary anemia. Roent-

genographic examination of the thorax gave evidence of active pulmonary tuberculosis; it suggested, furthermore, the presence of cavitation in the upper lobe of the left lung and fibrous tuberculosis in the upper lobe of the right lung. Examination of the sputum for *Mycobacterium tuberculosis* gave a negative result at this time but several positive specimens were obtained later.

Total acidity of the gastric content was 40 and free acidity 30, according to the method of Töpfer. *Mycobacterium tuberculosis* was found to be present in the gastric content. Roentgenoscopic examination after a barium meal disclosed the presence of an ulcerating carcinoma in the distal half of the stomach; the lesion appeared to be operable locally.

Proctoscopic examination of the rectum and rectosigmoid for a distance of 24 cm. demonstrated a freely movable carcinoma, measuring 4 by 2.5 cm. at its base, involving the left and posterior rectal walls at a distance of 15 cm. from the anus. A specimen taken for biopsy at the time of the proctoscopic examination was found to be characteristic of adenocarcinoma of malignancy graded 2 (Broders' method).

The clinical diagnoses were: (1) carcinoma of the stomach, (2) carcinoma of the lower part of the sigmoid and (3) pulmonary tuberculosis. Both carcinomas were believed to be operable.

Exploration of the gastric lesion was undertaken by one of us (J. deJ. P.) on November 22, 1943. Anesthesia was by intratracheal nitrous oxide, oxygen and ether. Preliminary examination through an upper midline incision revealed a carcinoma of the distal half of the stomach which had perforated onto the serosa and through the transverse mesocolon. The middle colic artery was not involved. Examination of the lower part of the sigmoid revealed a freely movable lesion which, it was believed, could be removed later by an exteriorization operation after adequate mobilization of the rectum. Metastatic lesions were not palpable in the liver.

The involved segment of mesocolon was removed without interference with the blood supply of the transverse colon, and resection of the distal half of the stomach was accomplished by turning in the end of the duodenum and establishing a posterior Pólya type of anastomosis. The lesion in the stomach was found to be an adenocarcinomatous ulcer

measuring 3 by 2 by 2 cm., of malignancy graded 3; it was on the lesser curvature of the stomach, 3 cm. above the pylorus. The lesion infiltrated the surrounding tissues to cover an area 6 cm. in diameter. Several involved lymph nodes were found.

On January 31, 1944, after an uneventful convalescence following the first operation, the lower part of the abdomen was entered through a low left rectus incision. Spinal anesthesia was employed. A small tumor was found in the lower part of the sigmoid, about 10 cm. above the peritoneal fold. There was no perforation of the wall of the bowel nor any adhesion of the sigmoid to surrounding structures. The left portion of the pelvic peritoneum was freed up and after the rectum had been mobilized, the portion of bowel about and including the tumor was brought out as the first stage of a Mikulicz exteriorization operation. On February 9, 1944, the exteriorized loop was removed, by means of a cautery, flush with the aponeurosis of the external oblique muscle. A clamp was applied to the spur of the colonic stoma. Examination of the 12 cm. of sigmoid colon removed, disclosed a sessile type of adenocarcinoma, of malignancy graded 2, measuring 5 by 3 by 1.5 cm., with nodal involvement. Convalescence was satisfactory and, on March 6, 1944, the opening in the colon at the site of the Mikulicz operation was closed around a small clamp applied to the remnant of the colonic spur. When the patient was dismissed on March 22, 1944, the colonic stoma had closed except for a small area which, it was believed, would close spontaneously.

#### COMMENT

Interesting is the fact that in this case both of the lesions were recognizable clinically. The majority of multiple primary carcinomas reported in the literature have been found at necropsy. In only two of eighteen instances of multiple, primary malignant growths reported by Hanlon<sup>2</sup> were the multiple growths recognized clinically.

It is now generally accepted that Billroth's<sup>1</sup> original criteria for the diagnosis of multiple primary malignancy are too strict, and the rules substituted by Warren and Gates<sup>7</sup> are considered adequate: (1) Each tumor must present a definite picture

of malignancy. (2) Each tumor must be distinct. (3) The probability of one tumor being a metastatic growth from the other must be excluded.

Since 1937, two cases in which primary multiple carcinomas occurred simultaneously in the stomach and colon have been reported. Maingot,<sup>3</sup> in 1938, reported exteriorizing a small carcinoma at the commencement of the sigmoid colon and subsequent subtotal gastrectomy for a simultaneous malignant growth in the stomach. Tullis,<sup>6</sup> in 1942, in a review of 1,044 necropsies, mentioned one case in which malignant growths occurred simultaneously in stomach and ascending colon. Stalker, Phillips, and Pemberton,<sup>5</sup> in 1939, mentioned a patient who in 1936 underwent resection of a portion of the descending colon which contained an adenocarcinoma of malignancy graded 2 and, in 1937, appeared with an adenocarcinoma of the stomach, graded 4. The malignant tumors in this case, however, do not appear to have occurred simultaneously.

These three, with our case, make a total of thirty-eight reported instances of independent carcinomas which involved the colon and stomach and, so far as we know,

the case reported in 1937, the case reported by Maingot,<sup>3</sup> and the case herein cited are the only recorded instances of successful surgical removal of simultaneous, independent carcinomas of the stomach and sigmoid colon.

We are pleased to add that a communication in February, 1944, from the patient whose case was reported in 1937, informed us that he was alive and in good health. Eight and a half years have elapsed since his operation.

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# OSTEOID OSTEOMA\*

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**O**STEOID osteoma, which has been recognized for a long time under the title of non-suppurative or sclerosing osteomyelitis, is a lesion which can usually be readily diagnosed. But at times its identification may present difficulties, particularly if its location is in a position which does not permit accurate roentgenographic visualization, or if there is an associated tissue reaction which simulates another disease.

Clinically osteoid osteoma has a triad of significant features which should always lead at least to a suspicion of its existence: First is localized pain. The onset of pain, usually in an extremity, is gradual. The pain at first mild and intermittent increases in severity and, after a variable period of some months, becomes persistent and continuous. The greatest intensity of the pain is always in the *same location* and is characteristically limited to a *comparatively small area* which may be surrounded by a large surface with less severe pain. Second, if the area of the lesion is accessible to physical examination, and it usually is, there is *tenderness* to pressure in the region of the greatest intensity of the pain. And, even when there is a wide spread perifocal reaction and general sensitivity, the most marked tenderness will still be limited to a small zone or spot. Third, the roentgenogram exhibits a small round or oval rarefaction of bone at the approximate site of the pain and tenderness. The rarefied area is surrounded by a zone of sclerosis which may appear as a narrow ring or may extend for several inches beyond the central focus. The triad of localized pain and tenderness and the pathognomonic roentgen changes are not

accompanied by any systemic disturbance. The customary laboratory tests are negative. The functional disturbance depends upon the location, duration of the lesion and the patient's sensitivity to pain. Even in instances of extensive perifocal sclerosis there is little inhibition of motor function unless the lesion is adjacent to a weight-bearing joint.

As an example of the typical osteoid osteoma I would like to cite the case history of a patient recently treated at the hospital:

## CASE REPORTS

R. L., a boy of seventeen years, consulted me in August of last year for pain in the upper part of the left leg and a limp. About four months previously, without any known trauma or pre-existing illness, he began to experience pain in the leg. This occurred infrequently and he paid no attention to it. Gradually the pain increased and he occasionally limped. Neither the pain nor the limp interfered with his physical activity, and he continued to work as a farmer's helper and indulged in vigorous athletic exercises. In recent weeks the limp became more noticeable, the pain more intense and he observed that his leg hurt whenever he chanced to press it against a hard object such as a table leg. The examination revealed a mild swelling on the outer surface of the upper part of the leg and tenderness to pressure over the upper extremity of the shaft of the fibula in the area of the pain. An x-ray film (Fig. 1) showed a typical lesion in the upper metaphysis of the fibula. There was an irregularly oval rarefaction within the fibula surrounded by an extensive bone sclerosis. The diagnosis was confirmed at operation and by the subsequent pathological examination. The lesion was excised completely by resecting the involved segment of the fibula and the patient has been entirely relieved.

\* Read before the Clinical Society of the Hospital for Joint Diseases, March 14, 1944.

In the exceptional or complicated case the diagnosis may be very difficult. At times the final opinion may have to be

backache continued. More x-ray films were made and a diagnosis of osteochondritis of the spine was suggested. She was then hospitalized,



FIG. 1. Typical osteoid osteoma of the fibula. There is an oval area of rarefaction in the upper metaphysis surrounded by an extensive osteosclerosis.

postponed until the pathologist examines the diseased tissue.

As an example of this type of problem I wish to recount the experiences in a girl, ten years of age, who had been complaining of backache for about a year. The symptoms started in October, 1942, shortly after she had begun having dancing lessons. The specific complaint was pain in the dorsolumbar region of the spine. Since she had previously been well it was assumed that the dancing exercises had initiated a strain of the back. Rest did not relieve her pain. A subsequent roentgenogram allegedly showed a mild lumbar scoliosis for which corrective exercises were prescribed. The

traction was applied for several weeks and finally a plaster of Paris jacket was put on for support of the back. All during this time the pain continued and in fact became worse. Lateral roentgenograms showed a slight kyphos at the level of the first and second lumbar vertebrae with diminution in the size of the intervertebral disc between these vertebrae. At this time a diagnosis of possible early Pott's disease was entertained.

When I first saw her she complained of severe pain in her back *only* in the region of the first and second lumbar vertebrae. In this location there was tenderness to pressure on the right side of the spinous processes and no where else. She did have a mild left lumbar scoliosis. But

I discounted this as the likely cause of her pain because scoliosis in children is almost never a painful deformity. The roentgenograms, both

The patient has been completely relieved of her backache and is rapidly regaining full function of the spine.

In retrospect the error committed here lay in the failure to recognize a small but quite definite laminar erosion in the second lumbar vertebra. In this case, as in other osteoid osteomas, the triad of symptoms and signs was present. The pain and tenderness and the roentgenographic findings were all located in the same area.

I wish now to report a case which has many interesting features, one which, in point of difficulty in differential diagnosis, lies between the two cases previously described:

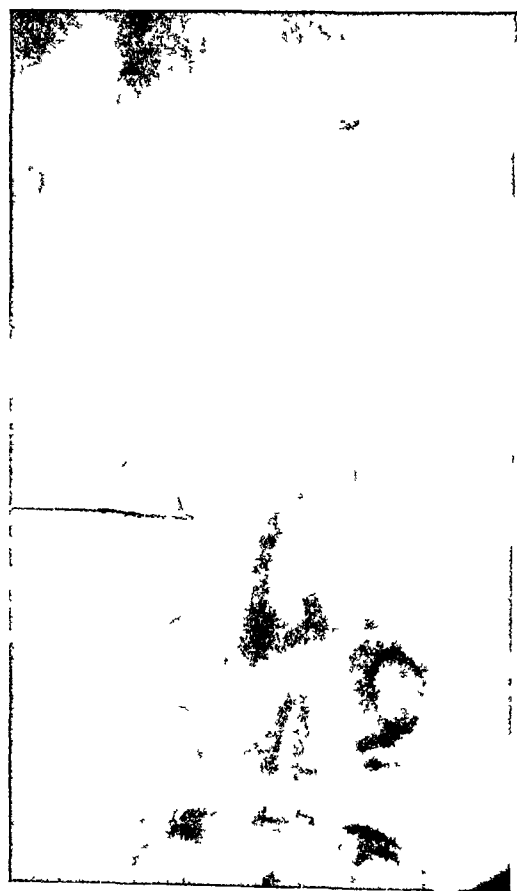


FIG. 2. Note the absorption of the upper margin of the right lamina of the second lumbar vertebra.

those which I had taken and all previous ones, showed an unusual lesion. There was an excavation in and an absorption of part of the right lamina of the second lumbar vertebra (Fig. 2), which had been missed by her previous physicians. I was uncertain of the exact diagnosis but advised an exploratory operation believing that there probably was a neoplasm which was eroding the lamina.

At the operation I found a cherry-sized red, granular mass between the laminae of the first and second lumbar vertebrae on the right side with erosion of a part of the lamina of the second lumbar vertebra. I removed this mass and then did a hemilaminectomy on the first and second lumbar vertebrae to allow inspection of the dura, and to make sure that I had left none of the diseased tissue. The pathological diagnosis was osteoid osteoma.

M. N., ten years old, began to experience some pain in the front of his left ankle in the summer of 1942. I was consulted in September, 1942. At that time he had a mild circumferential swelling of the ankle and a mild limp. He pointed to the front of the ankle as the site of his pain, and in this region he had exquisite tenderness to pressure. The localization of the pain and tenderness led me to suspect an osteoid osteoma of the astragalus, although the swelling of the ankle and the limitation of the lesion to one joint compelled me to keep in mind the possibility of a tuberculous arthritis. An x-ray film showed what I believed was a small area of rarefaction in the neck of the astragalus near the subastragaloid joint. I advised an operation which was refused. I next saw the patient one year later, in October, 1943. During the intervening time the pain and swelling had increased and the boy could no longer bear weight on the affected foot. He had been immobilized without relief. He had had an arthrotomy at another hospital where nothing but congestion of the synovia of the ankle joint had been found. Unfortunately, the exploratory incision had been made over the anterolateral aspect of the ankle so that the body but not the neck of the astragalus had been exposed, and hence the lesion was missed.

When I saw him in October, 1943, there was a very marked swelling of the ankle including both sides of the heel cord. The pain was, however, located over the neck of the astragalus. There was to be sure generalized tenderness, but this was most marked and very acute

in the region of the neck of the astragalus. New x-ray films (Fig. 3) showed an unmistakable lesion in the neck of the astragalus, not

revealing the front of the body and the neck of the astragalus. There came into view on the superior surface of the neck a circular area,



FIG. 3. There is an oval area of rarefaction within the substance of the neck of the astragalus near its upper margin. There is a narrow zone sclerosis.

in the lower part of the neck as I had imagined in 1942, but in the upper part. There was a circular, sharply-defined rarefaction about three-eighths of an inch in diameter. The process appeared to be within the substance of the cancellous tissue just below the superior surface of the astragalus.

There appeared now no doubt about the nature of the lesion and reoperation was urged which was performed by me on January 27, 1944. An incision about three inches long was made on the anterior surface of the ankle. The incision was directly over the neck of the astragalus and lay along the line between the tendons of the extensor hallucis longus and the long extensors of the toes. Much granulation tissue was found in the angle between the tibia and the foot. This was excised exposing the anterior capsule which was greatly congested, thin and frayed out. The segment of the capsule in the operative area was removed

about a half inch wide, of roughened congested bone denuded of periosteum. This area was sharply circumscribed. On either side the bone appeared normal. The area of diseased bone in the neck of the astragalus corresponded to the region of the pain, tenderness and roentgenographic findings. It was completely excised. A check-up x-ray film (Fig. 4) showed that all of the disease had been removed. A subsequent pathological examination confirmed the diagnosis of osteoid osteoma. The relief from the pain was dramatic, for when the boy awoke from the anesthesia he volunteered the information that he was free of the pain. He has not had any pain since then.

#### COMMENTS

The problem in this patient was, from the point of view of diagnosis, confused by the presence of a generalized swelling

and sensitiveness of the ankle with pain on attempted weight bearing. This condition limited to a single joint naturally

almost any other kind of an arthritis without an abscess and without systemic disturbance splinting of the affected joint



FIG. 4. Check-up x-ray film made at the time of operation to assure the complete removal of the central nidus of osteoid tissue.

inclined one to the diagnosis of an arthritis, probably tuberculous. The opinion was strengthened by the equivocal x-ray findings in the early period of the disease, and more specifically by the general haziness of the joint, which is one of the earliest roentgenographic changes in tuberculous arthritis. The absence of evident bone destruction or erosions of the articular surfaces of the ankle joint could be accounted for by the existence of a synovial lesion which had not yet invaded bone or had involved it so little that there was not sufficient destruction for roentgenographic visualization. On the other hand immobilization of the ankle and freedom from weight-bearing had given no relief whatever. In a tuberculous or

almost uniformly reduces the pain. In addition the boy's complaint was always referred to one area, that of the neck of the astragalus. The greatest tenderness was found in this location. The tenderness in this disease, as in acute osteomyelitis, must be tested for very gently and deliberately by slowly palpating one small area after another. In this way only can the exact site of the lesion be identified. The persistent localized pain and tenderness in this case should, therefore, have led to the suspicion of a lesion other than a tuberculous arthritis, and impelled further and repeated x-ray studies in several different planes before an arthrotomy was undertaken.

## SUMMARY

There is here recorded the detailed history of an instance of an osteoid of the neck of the astragalus in a child. In the early stages of the disease there was such a marked swelling of the ankle extending up along the heel cord that the clinical appearance suggested the diagnosis of a tuberculous arthritis. Immobilization gave no relief, and an arthrotomy did not disclose the real pathological process. The persistence of the greatest pain and tenderness in the anterior portion of the

ankle in the region of the astragalus, and the final appearance of a localized rarefaction in the neck of the astragalus led to the correct diagnosis, and the surgical cure of the disease. The specific purpose of this report is to direct attention again to the disease, osteoid osteoma, which is fairly common. It is a lesion with a triad of characteristic subjective and objective symptoms. Osteoid osteoma will be recognized more frequently if these symptoms and the possible existence of this disease are kept in mind.



*Treatment* of secondary malignancy of bone is palliative. Support and fixation should be used for fractures; irradiation, opiates, nerve blocking, chordotomy or rhizotomy for the pain.

From "Principles and Practice of Surgery" by W. Wayne Babcock (Lea & Febiger).

# SURGICAL AND MEDICAL MANAGEMENT OF TUBO-OVARIAN ABSCESS\*

## CASE REPORT

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THIS case is of interest not only from the surgical aspect but from the medical as well. While the patient's recovery was due to surgical interference, still one cannot deny that medical management made it possible to bring the patient to surgery. With the progress of the medical science, it might be that new combinations of drugs will be used in combating disease, but the fundamental idea of preparing the patient medically to build resistance and lessen danger of unavoidable operation will remain the same.

The drugs used, S.U.M. 36, is a symmetrical urea of M-benzoyl-M-amino-benzoyl-1-amino-8-naphthol-3:6-sodium sulfonate (1 per cent sterile solution) and S.U.P. 468 is the symmetrical urea of p-benzoyl-p-amino-benzoyl-amino-naphthol 4:6:8 sodium sulfonate,  $\frac{1}{10}$  per cent. This drug stands chemically somewhere between trypanosomiasis drug, called Bayer 205 and the sulfa drugs. S.U.P. 468 is another predecessor of the sulfa drugs. The effective dose is very small and a toxic dose is very large. Both of these drugs have been devised by J. E. R. McDonagh in London and manufactured by British drug houses. The adrenal cortex was used to stop the leakage of the fluids from the capillaries and to strengthen the musculature of the patient, including the heart muscle.

## CASE REPORT

Miss McE., aged thirty-five, entered Wesley Memorial Hospital on Saturday, April 24, 1943, acutely ill. Her illness started one week previ-

ously by an elevation of temperature. The next day she had chills and fever. In the middle of the week, Wednesday, a physician was called and after examination made a diagnosis of an acute condition of the abdomen and prescribed sulfanilamide. On Thursday, the patient passed some blood clots from the vagina. On Friday, she began to have violent pains over the abdomen.

The patient weighed 126 pounds; her height was 5 feet 4½ inches. Her temperature was 104°F. and blood pressure 127/90. The pulse was of good volume, rhythmic and 84 to the minute.

Her last menstrual period was April 10th; the previous period was at the regular time in March. Both menstrual flows were of three days' duration. The onset of menstruation was at thirteen years of age, once per month, of three days' duration, using two to three pads per day. She never had dysmenorrhea.

An inventory of symptoms was negative except for weakness. When twenty years of age she underwent an appendectomy. The patient cannot recall any childhood diseases. She had no venereal diseases and no trauma. As to her habits there was nothing worthy of note except that the patient was an expert equestrian.

The patient's grandmother was a Cherokee Indian. Her mother was living and well. Her father at the age of seventy was killed accidentally. The patient had two healthy sisters and there was no history of serious diseases in the family.

General examination of the patient revealed a rigid abdominal wall, pronounced meteorism, and a mass in the pelvis. Bimanual examination disclosed tense, right adnexal enlargement, the size of a large closed fist. The uterus was sinistroposed and the left adnexa was not palpable.

\* Read before the Chicago Gynecological Society, October 15, 1943.

The patient's temperature varied between 101 and 103°F. Red blood cells were 4,400,000, hemoglobin 80 per cent, leukocytes 11,800; polymorphonuclears 84 per cent, lymphocytes 16 per cent. Blood serum Kahn reaction was negative. Sedimentation test was rapid. There was no growth in blood culture. Ashheim-Zondek test was negative. Urine: Specific gravity 1.018; twenty-four-hour output over 2,700 cc.; albumin 30 mg., occasional red blood cell, four to five white blood cells, no casts. In subsequent days the albumin in the urine disappeared. A cervical smear was negative for gonococci.

Sulfathiazole was given to the patient and 2,000 cc. of 5 per cent dextrose intravenously. The fluids were repeated April 25th, 26th and 27th. A physiological salt solution was added. Prostigmine, 1:2000, was given every four hours. Sulfathiazole was discontinued due to toxic effect. On April 29th, an x-ray of the abdomen was taken and some gas in the course of the gastrointestinal tract and the soft shadow in the pelvis not sharply demarcated were detected. The patient continued to receive intravenous fluids but in spite of this treatment she became alarmingly dehydrated. We presume the dehydration was caused by a leakage of fluids through the interspaces between the epithelium of the capillaries.

On May 1st, 250 cc. of blood plasma was given intravenously and S.U.M. 36 and adrenal cortex intramuscularly were given. On May 3rd, her temperature dropped to 99.8°F. but at evening it rose to 102.9°F. and continued to be elevated the following days. On May 9th, yellow grayish pus was aspirated with a syringe from the cul-de-sac, after which a semilunar cut was made on the posterior fornix with scissors. The peritoneum was opened and about one-half glass of pus was evacuated. A rubber tube was inserted and attached with a silk stitch to the fornix. Our expectations that the patient's temperature would drop were not realized; the temperature continued to be elevated. After operation 500 mg. of cevitic acid was added to the intravenous fluids.

On May 22nd, the red blood cell count showed 3,600,000, hemoglobin 85 per cent, leukocytes 7,600. On the same day injections of 2 mg. of S.U.P. 468 were injected and 250 cc. of blood plasma and reticulogen was injected.

On May 25th, 250 cc. of blood plasma again was given. On May 30th, feeding with dexin was begun. The patient's temperature continued to be from 101 to 102.9°F. She lost over twenty pounds in weight and was very weak and apathetic.

On June 2nd, under cyclopropane anesthesia the posterior fornix and peritoneum were opened and enlarged through the old scar. The index finger was introduced and the uterus was found pressed to the left. The left adnexa could not be outlined. The right ovary was enlarged to the size of a goose egg and was soft and bulging. With the finger the ovary was pierced to make a road for approach to the tube. Sanguineous purulent content with decayed ovarian tissue were evacuated. No bleeding took place evidently due to thrombosis of the ovarian artery. The finger then approached the thick, tense wall of the tube which was enlarged to the size of a closed fist. Sliding along the palmar surface of the pointed index finger pressing against the tube wall, a long curved scissors was introduced and by pressure the tube was pierced and the opening enlarged. Pus flowed in abundance. A rubber tube was introduced and the wound packed loosely with gauze. On the way of reaching the ovary and tube there were many string-like tense adhesions running in different directions.

On the day of operation the patient's temperature was 102.8°F. The next day it rose to 105°F. After two days it dropped to 100.2°F. and for the following ten days it fluctuated between 99 and 101°F.; for the eleven subsequent days the temperature was between 99 and 100°F. On June 23rd, the temperature dropped to normal and on June 29th, the patient was discharged.

The patient was seen several times after leaving the hospital. On her visit November 22, 1943, the uterus was found in the midline, slightly enlarged, symmetrical, firm, smooth, not tender, with limited movability. The left adnexa was normal. The right adnexa was enlarged, about the size of two finger width. The patient had regained her normal weight.

The last time the patient was seen and examined, April 24, 1944, a slight enlargement of the right adnexa was found. The patient had had no pains in the lower abdomen from September, 1943, up until the present time. She does secretarial work and at no time was absent from her duties.



# SARCOMA OF THE SMALL INTESTINES

## CASE REPORT

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**S**ARCOMA of the small intestines is a rare condition. Ralleston reports four cases in 18,000 necropsies, Schlesinger seventeen in 42,000 necropsies and Staemler thirty-three in 54,000. Unless there are duplications of records, forty-four cases of sarcoma were encountered in 114,000 autopsies. According to the literature, the condition is rarely diagnosed before death unless an operation is performed for acute obstruction or a palpable tumor is responsible for the operation. Therefore, forty-four cases in 114,000 autopsies or .0003 per cent is a fairly accurate estimate of occurrence of sarcoma of the small intestines.

In 2,200 cases of intestinal cancer there was one case of sarcoma. Nickerson and Williams reviewing 11,206 autopsies over a period of forty years report ten cases of malignancy of the small intestines, two of which were sarcoma. Rowley reports that in 1,500 laparotomies at the Hartford Hospital there was only one sarcoma of the small intestines. Gotten of Memphis found four sarcomas of the small intestines in a review of 20,000 case records. Up to 1939, Hartman had found only twenty-seven cases of sarcoma of the small intestines in the Mayo Clinic's records. From 1924 to 1939 inclusive, a period of sixteen years, 217,468 patients were admitted to the Shreveport Charity Hospital (a state institution). According to the records, there were three cases of sarcoma of the stomach, one sarcoma of the mesentery and small intestines, one of the rectum and one diagnosed as sarcoma of the small intestines alone, all discovered either at exploratory operation or autopsy. This

latter case was a white male infant, age four, brought in acutely ill with distended abdomen and a mass in the upper right quadrant attached to the liver. Death occurred following exploratory laparotomy. Most writers insist that sarcoma of the small intestines, like carcinoma, is more prevalent in the duodenum. However, Smaller who reviewed the records of 13,036 malignancies of the gastrointestinal tract, found thirteen sarcomas, six of which were in the jejunum and none in the ileum. Of the 39,444 admissions to the Edward Hines, Jr., Hospital, the one sarcoma recorded was in the jejunum.

*Types.* According to Ewing, a sarcoma may rise from any mature mesoblastic tissue. In the small intestines this includes the submucosa, subserous connective tissue and the muscular coats. "Histologically this accounts for the finding of fibrosarcoma and leiomyosarcoma as the most frequent types of sarcoma of the intestines." Adenosarcoma, lymphoblastoma or lymphosarcoma, liposarcoma and sarcoma engrafted on the various types of benign tumors found in the intestines might be encountered.

*Symptoms and Diagnosis.* The diagnosis of sarcoma of the intestines like all diagnoses is predicated upon the symptoms. Unfortunately, the symptoms are inconstant, variable and at times bizarre. If the tumor is situated in the duodenum, there may be nausea, vomiting and other gastric disturbances. If the tumor arises from the submucosa and is projected into the lumen of the bowel, obstruction either partial or complete with the accompanying symptoms are present. However, when the tumor arises

from the muscular or subserous coats, the tumor projects out into the abdominal cavity and presents no symptoms other than those usually encountered in various

sis alone is nothing on which to hang a diagnosis of sarcoma of the small intestines. This is merely mentioned as of passing interest.



FIG. 1.

FIG. 1. Mucosal aspect of tumor.



FIG. 2.

FIG. 2. Surface of tumor made by section.

tumors of the abdomen not attached to the bowels. In some cases there may be a dragging or pulling that might suggest bowel attachment, but this same symptom is not infrequent with other abdominal tumors. Constipation, diarrhea or even bloody or mucous stools may occur but are inconstant. If one is hot on the scent of this condition, certain x-ray signs such as dilated intestines, malpositions, etc., may be read into the picture; but on the whole, roentgenograms are not very helpful in diagnosing sarcoma of the small intestines. In reviewing a number of case reports in the literature, the one constant symptom or sign was leucocytosis. The total white counts would range from 15 to 20 thousand with a rise of polymorphonuclears from 80 to 95 per cent. Why this occurs I am not prepared to answer. Perhaps it was that the great majority of these patients were operated upon because of symptoms of obstruction. However, the case which I shall report exhibited repeatedly acute fever and leucocytosis without any evidence of obstruction at any time. We are all aware that leucocyto-

*Prognosis.* The prognosis is good in sarcoma of the small intestines, at least much better than in carcinoma of the small intestines. This is because the tumor is easily removed by resection of the bowel, and when metastases do occur, it is very late in the course of the disease. Nickerson and Williams (from the Mallory Institute of Pathology, Boston City Hospital), reporting in detail on ten primary malignancies of the small intestines (eight carcinoma and two sarcoma), found metastases in seven out of eight carcinomas and no metastases with the two sarcomas.

#### CASE REPORT

Miss C. B., sixty years old, called my attention to a freely movable hard tumor in the left iliac region while I was attending her for an attack of influenza six months previous to the operation. She had noticed the tumor about one year previous to the influenza attack, but it had been producing no special symptoms. The tumor apparently did not grow larger during the six months period previous to the operation. However, she had unusual attacks of hyperpyrexia with leucocytosis whenever she walked a few city blocks. Rest

in bed for a few days would cause her to become fever-free with a return to normal blood counts. The urine was always negative. The bowels moved regularly without medication. There was no loss of weight nor no nausea or vomiting. The heart and lungs showed no pathologic condition; the blood pressure was 130/70. A slightly ptosed left kidney could be felt through a very thin abdominal wall.

The tumor which seemed upon palpation to be the size of the fist of a very large man, was freely movable in the lower left abdominal region. There was very little pain when the tumor was manipulated. X-ray of the gastro-intestinal tract by a competent radiologist was reported negative as to any evidence that the tumor involved any part of the intestines. The day she was operated upon her blood picture showed some anemia (red blood count 3,970,000, hemoglobin 70 per cent, leucocytes 7,800, small leucocytes 28, neutrophils 72).

A diagnosis of possible pedunculated fibroid of uterus was the preoperative diagnosis. In fact, so sure was I of my diagnosis, that the abdomen was opened with the patient in the Trendelenburg position. But when I put my hand in the abdomen the tumor was not there. However, I soon found it in the upper abdomen with some slight omental adhesions, and the diagnosis burst before my eyes. The tumor, about 7 cm. in diameter, was jutting out from the walls of the upper portion of the jejunum. The tumor with several cm. of healthy intestines was removed, an end-to-end anastomosis performed, 75 gr. of sulfanilamide scattered over the line of sutures and the abdominal cavity and the abdomen closed without drain-

age. One blood transfusion, intravenous sulfanilamide, glucose and saline and thiamin chlorid were administered postoperatively. She made an uneventful recovery and was removed to her home on the tenth day after the operation.

The tumor was of the cystic variety, not infrequently described by pathologists, and involved the muscular coat of the intestines. There was a small concaved button-like prominence inside of the bowel, but not large enough to interfere with the flow through the lumen. The pathological diagnosis was low grade leiomyosarcoma of the intestines.\*

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\* The patient is still in good condition fifteen months after the operation. Pathological diagnosis by Dr. W. R. Mathews, Pathologist of the Shreveport Charity Hospital.



# HEMATOSALPINX IN A FEMALE INFANT

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**T**HIS case is presented in order to illustrate a condition which should be in the mind of every surgeon operating upon an acute condition of the abdomen in a female infant. Although fortunately rare, its association with peri-appendicitis is apt to cause the underlying pathological process to be overlooked unless a thorough examination of pelvic viscera is done in every case.

## CASE REPORT

A thirteen month old female infant was admitted to the hospital with the diagnosis of acute condition of the abdomen, probably acute appendicitis. The past history revealed no previous illnesses, and father and mother were living and well. She had no brothers or sisters. The baby was delivered with low forceps following an episiotomy, after mother had received adequate prenatal care. The puerperium was uneventful. The infant's health had been excellent up until the present illness.

The chief complaints were elevated temperature, abdominal cramps, and history of gastrointestinal upset of thirty-six hours' duration. The mother stated that the baby had what she considered "intestinal flu" three days ago. The attack was accompanied by loss of appetite, temperature elevation to 100.4°F., numerous watery stools, and vomiting of part of the feedings. This subsided on the first day. The following day the baby had no bowel movements, appeared restless and feverish, and cried as though in pain. She vomited once. The day before the writer was consulted, the infant had two enemas with only hard, constipated, marble-like stools without appreciable improvement. She was seen at 1 A.M. of the day of admission, when it was noted that her abdomen was tense and rigid. The right leg was kept flexed on the abdomen. Extension of this leg caused apparent pain. Immediate hospitalization was advised.

Physical examination showed a well devel-

oped, well nourished child of thirteen months. Fontanelles were under no pressure. The pupils reacted well. There was no evidence of rhinitis and the throat was clear. The tongue was slightly dry. No râles or adventitious sounds in the chest were heard. The heart sounds were of good quality with no murmurs. The abdomen showed tenderness and spasm with rigidity, more marked on the right, slightly below McBurney's point. The right leg was semi-flexed, and extension caused the child to cry out with pain. There were no evidence of masses on rectal examination, but the child was apparently tender in both vaults.

Consultation was held with two staff members and consensus of opinion was that child had acute appendicitis, and immediate surgery was advised. Blood count taken on admission showed hemoglobin of 100 per cent; red blood cells of 5,210,000; white blood cells 18,750; polymorphonuclears 54 per cent, lymphocytes 42 per cent, and large monocytes 4 per cent. Color index was 9 per cent. Seven hours later repeat blood count showed 18,050 white blood cells, 70 per cent polymorphonuclears, 18 per cent lymphocytes, 4 monocytes, and 8 eosinophiles.

Twelve hours after admission to the hospital the baby underwent surgery. Under ether anesthesia a right rectus incision was made and the muscle retracted medially. When the peritoneum was opened about 20 cc. of brownish, serous fluid exuded. The appendix delivered without difficulty and was removed by clamp, tie, carbolic knife, and alcohol. Mesentery to appendix was suture ligated and the stump attached to the tab. Exploration of the pelvis revealed a semi-circular mass, hard, bluish-black in color, which was identified as the right tube and ovary. This was delivered into the wound. The tube and ovary were clamped at the fundus, removed, and the fundal end suture ligated and peritonealized. Examination of the left tube and ovary, and uterus showed them to be normal. The wound was closed in the usual manner, without drainage.

The abdomen contained about 20 cc. of brownish serous fluid which was odorless. The appendix showed considerable peri-appendiceal injection, without adhesions. The right tube was markedly swollen and gangrenous. The right ovary was swollen, under considerable pressure, and filled with blood.

The pathological report was as follows: Gross examination: Specimen consists of (1) an irregular mass, measuring 3.5 by 3.3 by 2 cm. which consists of a tortuous tube, and a smooth ovary, having a purple red surface. Section through the ovary reveals nothing which can be recognized grossly as ovarian tissue. The appearance of the whole is that of firm red blood clots although beneath the capsule some small cystic areas can be made out. The tube also shows only thick blood clot obliterating the structure and this tube measures from 5 to 9 mm. in diameter. (2) An appendix 4.5 cm. in length and 6 to 8 mm. in diameter. There is considerable congestion of the greater part of the serosa which is dull. Section shows considerable thickening of the walls and a little fecal material in the lumen. Gross diagnosis: (1) Infarction of the tube and ovary, hematosalpinx; (2) acute peri-appendicitis.

Microscopic examination of the tube and ovary both shows only a delicate fibrous loose stroma with few recognizable typical structures, since both are so engorged with free blood as to obscure the underlying structures.

The appendix shows a slight fibrous thickening of the walls with few lymphocytes and rare polymorphonuclears. The surface is covered by a layer of fibrin and polymorphonuclears. Pathological diagnosis: (1) Acute infarction of tube and ovary, hematosalpinx; (2) acute peri-appendicitis.

It is difficult to be dogmatic as to the cause of the infarct. It is possible that an embolus was formed in the vessels supplying the tube and ovary due to the contiguity of these structures to intestine altered by gastroenteritis. Because of the relative infrequency of an infarct of the tube and ovary in infancy, the correct preoperative diagnosis will seldom be made. This should be of little concern, however, as the condition is acute, and early surgical intervention is essential.\*

#### SUMMARY

A case of infarct of the tube and ovary with peri-appendicitis in a thirteen month old female is presented, showing the necessity of a thorough examination of the pelvic viscera in the female infant with acute appendicitis.

\* The patient made an uneventful recovery and four months later was eating and sleeping well, had gained in weight, and there has been no history of gastrointestinal or pelvic disturbance since the operation.



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# Bookshelf Browsing

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JAMES BOLTON (1812-1869)

EARLY PROPONENT OF EXTERNAL SKELETAL FIXATION

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THE history of medicine contains numerous examples of identical discoveries made independently by different individuals.<sup>1</sup> In some instances the two discoveries were made almost simultaneously while in others considerable time had elapsed between them. This is no less true in the history of orthopedic surgery. Lister's operation for the fracture of the patella in 1877 was successfully performed sixteen years earlier by Cooper, an American, using alcohol as an antiseptic. J. H. Rodgers, another American, successfully wired an ununited fracture of the humerus in 1827, forty-six years before this method was used for fracture of the mandible by Thomas. The method of drilling the bone ends to hasten union, though introduced by Bohler, of Vienna, after the last war, was described eighty years previously in Brainard's essay published in New York.<sup>2</sup>

The treatment of fractures by external skeletal fixation is a relatively recent development in orthopedic surgery. Nevertheless, we find a rather complete description of this method by James Bolton as early as 1864 with a report of a patient treated in 1853.

Bolton presented his method in the Confederate States Medical and Surgical Journal while he was a surgeon in the Confederate States Army.<sup>3</sup> At the time his "New Method of Treating Ununited Fracture of Long Bones" appeared, he was serving as surgeon in charge of the 3rd Corps Receiving Hospital. His work

here offered ample opportunity to observe and become disturbed by the high mortality accompanying fractures of the long bones.

There is no evidence that James Bolton was at any time particularly interested in orthopedic surgery. A native of Savannah, he was taken to New York during his childhood, received his A. B. from Columbia in 1831 and his M. D. from the College of Physicians and Surgeons in 1836. After studying the diseases of the eye and ear with Dr. John Kearney Rogers and serving some time as clinical assistant to Dr. Valentine Mott, he began to practice in Richmond. In 1842, his "Treatise on Strabismus, etc." appeared. It contained a description of "the steel hook with its guard" which Bolton invented for the purpose of decreasing the drying of the eye and the temptation to wink during the operation. He also reported eight successful cases involving its use. His contribution was well received both in this country and abroad.

With the discovery of anesthesia, James Bolton became interested in its use. In 1851, he reported his experience with ether in operations on hemorrhoids. An article appearing in 1852 under the title "A Test for the Safety Point in Anesthesia" described his work with chloroform. This was a very pressing question at the time, since physicians were very much concerned about the safety of the new anesthetic agents. Bolton's work did much to encourage their use.

Moreover, he occupied a leading position in his profession. In addition to editing a medical journal and serving as chairman

attending surgeons, sick & wounded officers and men, and attendants such as cooks, nurses, etc. For these I now have scant rations for two



FIG. 1. James Bolton, M.D. and his wife, Anne Maria Harrison Bolton.

of important committees of the American Medical Association in 1858, he was president of the Medical Society of Virginia.<sup>4</sup>

James Bolton was fifty-one years of age when he left a lucrative practice to serve as a surgeon in the army. Nevertheless, he carried into his military work the energy and enthusiasm for his calling that was so evident in his earlier civilian life. His letter dated May 29, 1864 to Wm. A. Carrington, Medical Director of the Hospitals of Richmond, is revealing not only of the times, but also of the man.<sup>5</sup> In it he writes:

"Sir:

"Being unable to communicate with the proper medical officer in the field I have to state to you my present condition. There are at this post eighty-three persons including

days. This whole country has been drained of provisions so that the inhabitants have not a sufficient supply for domestic consumption. My small stock of stimulants is exhausted and I have but a few articles of medicine and those I am compelled to use sparingly. Under these circumstances it is not surprising that my rate of mortality is frightful and unless some relief be obtained all must die who have not strength of constitution to bear up against these adverse circumstances. I am utterly unable to give relief and can only stand by and see my men sinking for lack of medicine and sustenance. The picture which I have drawn of the condition of my hospital is but a counterpart to those of the other hos. corps in my neighborhood. In all these hospitals subsistence is required for about five hundred men. A considerable number of the sick and wounded will bear transportation and many

of the hospital attendants are able bodied men who ought to be with their commands.

"I therefore respectfully urge upon you to give your *immediate* attention to this subject. I respectfully suggest that a train of twenty ambulances and an equal number of wagons be forwarded to this post as promptly as possible sending by them subsistence sufficient to relieve our pressing necessities. On its return this train might be laden with the sick and wounded capable of bearing transportation. By two trips nearly all could be carried off and a large number of able bodied men could then be returned to their commands and the surgeons now almost uselessly employed could be returned to their respective posts of duty.

"By your prompt attention to the subject of this communication you will perform an act of humanity and greatly oblige

"Yours very respectfully,

"James Bolton, Surg., P.A.C.S.

"in chg. 3rd Corps Receiv'g hosp'l."

Bolton was not simply a civilian doctor in a military organization. He quickly grasped the fundamental principle that "In military service, it is not only the best method of treatment that must be considered, but one that permits treatment of a large number of casualties in limited time."<sup>6</sup> This is clearly exemplified in his evaluation of a vulcanite interdental splint which was developed during the war for treatment of fracture of the jaws by James Baxter Bean,<sup>12</sup> a Southern dentist. Bolton writes of Bean's device, "The interdental splint . . . appears to me to approximate perfection as nearly as we are likely to reach. The means of preparing it, however, are not always at hand. The splint hereafter described (using gutta percha) has the advantage of greater simplicity, of fulfilling the indications in a similar though less perfect manner and may be always within the reach of the surgeon."<sup>7</sup> It must be remembered that Bolton had spent the major portion of his professional life in civilian practice. Nevertheless, at the age of fifty-one he was sufficiently young and flexible to adopt wholeheartedly the viewpoint of the military surgeon.

It is this adaptability together with the humanity and professional integrity ex-

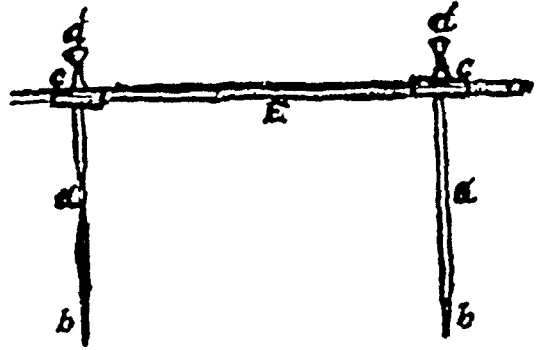


FIG. 2. James Bolton's "Instrument." "My observations," Bolton wrote, "on cases of gun-shot wounds of the thigh, with fracture of the bone, have impressed me strongly with the unsatisfactory character of the ordinary methods of treating them." After listing the many difficulties which accompanied these methods he stated that "Amputation is only an exchange of risk of death by exhaustion, for risk of death by shock." He then asked attention to his new method by which he proposed "to secure co-aptation, adaptation and quietude." The method which Bolton used in 1853 is described thus:

"Two steel rods, *a*, three inches in length were each cut at one end into a screw, *b*, three-eighths of an inch long. To the other end was attached at right angles, a hollow cylinder, *c*, having on its upper surface a screw, *d*. A steel rod, *e*, five inches long, completed the instrument. The patient was anaesthetized, and powerful extension was used until the limb was brought to the proper length. The point of a scalpel was then thrust down to each fragment, one inch from the extremity, and a hole was drilled in each as far as the medullary canal. In these holes the rods, *a*, were screwed. The ends of the bone were then adjusted by pressure upon one rod and by traction upon the other. When adjustment was complete, the cylinders, *c*, were in a line with each other. The rod, *e*, was then passed through them and secured by the screws, *d*. This rod was outside of the integuments, and was of necessity parallel with the shaft of the bone. The only motion then possible was a rotary one upon the screws. This was prevented by straight splints upon opposite sides of the thigh. The same thing might have been accomplished by applying another instrument at right angles to the first."

Bolton recommended that his instrument be applied to other long bones and to the lower jaw. (From *Confederate States Medical and Surgical Journal*, Vol. 1, No. 4, pp. 55-56, April, 1864.)

pressed in the letter to Carrington that probably forced his concern with the



problem of fractures. His ingenuity suggested the solution which he presented in his article.

The fact that we do not speak of a Bolton splint today is sufficient proof that his suggestion was not immediately embraced by an eager profession. Bolton himself indicates the reason for this in a footnote to the article describing his instrument. He states:

"It may be objected that by this method a simple fracture may be converted into a compound one, but a careful consideration will lead to the conviction that this result ought not to occur. In the case of gun shot wound the fracture is already compound."<sup>3</sup>

A glance at the surgical practise of Bolton's era will enable us to understand why this method was not adopted. W. W. Keen, the Philadelphia surgeon who served with the Union Army, described this period thus:

"A comparison between the danger of immediate death in battle or later from wounds in the Battle of Gettysburg, and of the danger of death from the surgery of Civil Life in the '60's, shows that it was seven times safer to fight all through the three days of Gettysburg than to have an arm or a leg cut off or to be run over and suffer a compound fracture of the leg and be treated in a city hospital, with the septic surgery we then practiced!"<sup>1</sup>

In these times the foremost surgical opinion held immediate amputation to be the best procedure for compound fractures of the long bones. Surgeons were reluctant to try the ordinary conservative methods at hand. Bolton's method must have seemed extremely daring and equally dangerous. In such a situation we can understand the failure of Bolton's method to take hold.

Unfortunately, as often happens in the history of science, the seed of James Bolton's new concept fell on the barren soil of pre-Listerian surgery. It could not possibly germinate at a time when a

surgeon as outstanding as S. D. Gross would begin an operation by giving "a last fine touch to his knife on his boot—even on the sole—and then at once use it from the first cut to the last."<sup>8</sup>

Strikingly enough, as Bick in his "Source Book of Orthopaedics" points out, it was not proved until the period following the last war with the work of Bohler "that the traditional fear of infecting bone was baseless in the presence of adequate asepsis."<sup>9</sup>

Shaar and Kreuz in their recent "Manual of Fractures" speaking of Bohler's influence in this direction say, "His persistent efforts and successes were chiefly responsible for the gradual elimination of pin phobia held then by many surgeons, and still retained by some today."<sup>10</sup>

If this hesitancy is still retained today, we can feel no less than admiration for Bolton's intrepidity and yet fully understand why it was not adopted by the surgeons of his day.

The last issue of the Confederate States Medical and Surgical Journal appeared in January, 1865, and the Confederacy collapsed three months later. James Bolton's "New Method" was buried with the journal for which he wrote and with the cause which he served.

Asepsis was introduced by Von Bergmann and formulated and developed by Simmelbusch in 1892, as a substitute for antisepsis.<sup>11</sup> In 1897, Clayton Parkhill, an American surgeon, introduced a new apparatus employing rigid fixation in the treatment of fractures of long bones.<sup>10</sup> This contribution being nourished by modern technical as well as medical science is still in the process of development today.

However, the story of James Bolton is not without meaning. It suggests that a study of the history of medicine must reveal a mine of prematurely conceived ideas. These ideas may require only transplantation into the more fertile environment of our modern scientific period

in order to bring them to the full maturity of practical utility.

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ONE requisite of a good stump is that the severed muscles receive a new insertion at the stump end. Redundant muscle tissue is useless and makes the stump more difficult to fit and prone to chafe. It is very important that cut ends of muscles or their tendons be grouped about the end of the bone and fixed to the periosteum and fascia or to each other so that they will not retract and leave the bone exposed beneath the skin after healing.

From "Operations of General Surgery" by Thomas G. Orr (W. B. Saunders Company).

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# Selected Book Reviews

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## AN APPRECIATION\*

THE appearance of the seventh edition of Flagg's "Art of Anesthesia,"\* twenty-seven years after the first edition had made its debut in the medical world, is sufficient testimonial of its worth and of the esteem in which it is held by the profession.

In 1916, on the eve of America's decisive entry into the first world war, the book came opportunely to meet the requirements of the great army of young medical graduates and others who were preparing for the surgery of the titanic conflict that was near at hand. Though not written from the military viewpoint, the book served an admirable purpose as scientific groundwork upon which the student could build a more comprehensive knowledge of the art of anesthesia as this applied to its many fields and phases.

Dr. Flagg's now classical text was unique from the start, not only because it condensed the lessons of the author's vast and varied experience as an anesthetist, teacher and consultant, in the most important hospital centers of surgical experience in New York, but because it was essentially a personal work, largely the work of a pioneer and a contributor to the evolution of anesthesia as it has so marvellously developed in the United States, the country of its real and historic birth. Besides, it was a book which dealt with fundamental principles in the physiological pathology of respiration and circulation, principles which govern the applications and technics of anesthesia and anesthetics, regardless of the birth and decline of new drugs and new methods.

How experience in anesthesia gathered in civilian practice is readily applied to the exigencies of war is shown by the attention and praise given to Dr. Flagg's lectures and demonstrations by groups of Army surgeons when the War Demonstration Hospital of the Rockefeller Institute for Medical Research was opened in 1917.

It is, no doubt, gratifying to Dr. Flagg that he can again render service to the profession after the lapse of over a quarter of a century,

\* The Art of Anaesthesia. 7th ed. By Paluel J. Flagg. Philadelphia, 1944. Price \$6.00.

by offering to the medical public a seventh edition of his "Art of Anesthesia" which, in its present revised form, should prove as timely and valuable an acquisition to the medical services of the battling American armies of World War II, as the first edition helped to train the anesthetists of the American Expeditionary Forces in 1917 and 1918.

Again, Dr. Flagg, animated by an altruistic and patriotic spirit and moved by the desire that the great progress accomplished in the art of surgical anesthesia in the United States should be shared by his medical brethren in Latin America, has published a Spanish edition which is offered to them as a gesture of good will and in token of a sincere and friendly effort at Inter-American medical collaboration.

Dr. Flagg's life-long interest and studies in the causes of asphyxial death and the means of preventing them, has vastly expanded his conception of the rôle of the anesthetist and his functions. While appreciating the importance of anesthesia as a special occupational field, he perceives inhalation anesthesia only as a part of a "new and major specialty," in which saving life threatened by asphyxia in its numerous and varied forms is the job for which the anesthetist is particularly fitted to fill and direct.

He believes that this triple function: *anesthesia*, putting people to sleep with gases to prevent pain, *resuscitation*, awaking people with or without the aid of gases, to keep them breathing and save them from asphyxia, and *inhalation (gas) therapy*, which treats disease by inhalation of therapeutic gases, when all combined in one personality—the trained gas specialist or *pneumatologist* (a term suggested by Carrel)—can render infinitely better service than when the allied functions are detached and exercised by separate individuals who are often chosen in emergencies.

These views have a pertinent bearing on the problems created by the war. As the author very properly suggests: "The officer receiving instructions as an anesthetist, should become acquainted with the nature and control of war gases, with the problems of high altitude flying; of submarine escape; of the effect of compressed air in diving bells, caissons, etc., with treatment of CO; poisonings; besides the knowledge of the diseases that are amenable to gas therapy." Such a man should be a qualified and accepted teacher of technical groups engaged not only in the study of anesthetics but

in the specialty of pneumatology in the broad sense in which this term has been defined.

The earnestness and enthusiasm with which Dr. Flagg has pursued his campaign of prevention against asphyxial death is seen in his inventions for the direct and more efficient application and maintenance of artificial respiration by intratracheal intubation and pulmonary ventilation or insufflation which have all contributed, since Meltzer's epochal discovery, to the present marvelous development of intrathoracic surgery. Dr. Flagg's interest and influence in rousing public attention to this vital subject is also seen in the work of the committee on asphyxia of the American Medical Association, the organization of a national society for the prevention of asphyxial death, of which he is president; and, again, by his establishment of a division of pneumatology in connection with the medical department of the World's Fair in New York, which attracted worldwide attention as an advance in the public knowledge of the dangers and prevention of asphyxial death which was far ahead of the times.

In this connection, the Preface that Dr. Flagg dedicates to the discussion of the principles and policies that apply to anesthesia in warfare will be read, we believe, with special interest by the authorities most concerned in the proper administration of this vital branch of operating service. It is evident that the methods of anesthesia must be adapted to the varying conditions met in the far-flung battle fronts of the present war, where surgery is often performed in the most varied, heroic and primitive surroundings. The methods of anesthesia must also be quite different in the outpost and casualty stations from those in the relatively safe and well organized base hospitals, where the choice of the anesthetic may be made deliberately to meet the requirements of the operation and of the patient. In the emergencies of the front, anesthesia must be obtained in the quickest and simplest way compatible with the means at hand and the condition of the patient.

It is under these circumstances that the experience and mature judgment of the author on the relative merits of the various anesthetics and anesthesia procedures best suited to meet the emergencies of surgery, as described in this book, will find their greatest value.

In regard to the choice of a routine general anesthetic, wherever such a choice is possible, the author's preference for ether, is most emphatic and unequivocal: "A personal experience with ether

(gas-oxygen ether) as an anesthetic has left the author cold to the claims of other agents suggested as basic routines." And his argument for ether "the anesthetic agent for general anesthesia in the armed forces and for civilian defense," is most eloquent and convincing.

Dr. Flagg's decided and well founded preference for ether does not mean that the claims of other rival candidates are neglected. On the contrary, chloroform, ethylene, cyclopropane, vinethene, etc., and the growing family of basal hypnotics and sedatives, no less than the methods of local, regional, spinal and caudal analgesia, are all passed in review and disposed of in brief, but lucid summaries and conclusions are given based on the mature experience and critical judgment of the author. The reader need not look here for long dissertations on controversial subjects or endless columns of bibliographic citations. This is a personal book—original in the best sense—the mirror of a man's lifelong experience—in which the stream of progress is viewed critically, lucidly and judiciously with stress on the solid things that lie in the depths without neglect of the things that float on the surface. And it is because of this fine sense of proportion and because of the high sense of responsibility and devotion to his art and to his fellows, revealed in every page of this fine book, that it will always command a distinguished and honorable place in the literature of anesthesia.

RUDOLPH MATAS.

When Dr. Novak's book<sup>1</sup> appeared two years ago, under the title of "Gynecology and Female Endocrinology," it was conceded that the author had written an excellent book. It had wide distribution among the profession. The fact that a second edition appears so soon is a guarantee that the material is well balanced, up-to-date and reflects the work of an experienced teacher and research worker.

We are sorry it was seen fit to drop "Female Endocrinology" from the title, because Dr. Novak has earned his right to the title of being one of the outstanding workers in this complicated and little known and appreciated field. We are sure that many readers took to the work because they believed Dr. Novak would set them

<sup>1</sup> Textbook of Gynecology. By Emil Novak. 2nd ed. Baltimore, 1944. The Williams & Wilkins Company. Price \$8.00.

straight on many matters of female endocrinology. By and large there is, and there has been, much bilge written on this subject, and between the claims of the pharmaceutical houses and many half baked pseudo-scientific authors, the average practitioner has been in a fog and often did not know which way to turn. If the practitioner would take the time to read this book by Dr. Novak, the fog would lift and the reader would know the better how to diagnose and treat many of his patients. Although the book as a whole is of a high standard, we think it is the section that deals with female endocrinology that gives it particular value.

The book is beautifully illustrated and some illustrations are in color. It has a Bibliography or "References" at the end of the chapters and an Index. Dr. Novak's work is a well balanced, solid and readable book.

The first edition of "Clinical Urology"<sup>2</sup> appeared in 1940. It received favorable and enthusiastic reviews. This reviewer gave it high praise, and in the second edition he has no thought of doing otherwise than repeat this high praise and say that it is a work both the authors and publishers can look upon with satisfaction and pride. It deserves a wide sale because the authors have written good English and made the book practical and useful.

In both editions the approach of general practitioner and general surgeon to genitourinary diseases is as fully considered as the requirements of the specialist in this branch of medicine. The work is a combination of embryology, anatomy and pathology with a manual of modern operative technic. The drawings were made at the operating table by William P. Didusch. The architecture of the first edition and the above mentioned basic foundation have been preserved and revised, and new material, bringing the work up to date, has been added to this second edition.

The work is in two volumes. A workable Bibliography is at the conclusion of each chapter and there is a detailed Index.

For student, practitioner, surgeon or urologist this book is warmly recommended because it is practical, authoritative and clear and there is so much condensed in its pages.

In 1913, the late Dr. DeLee completed the first edition of what has become and has continued to be for over thirty years one of the

<sup>2</sup> Clinical Urology. By Oswald Swinney Lowsley and Thomas Joseph Kirwin. 2nd ed., in two volumes. Baltimore, 1944. The Williams & Wilkins Company. Price \$10.00 per set.

most popular textbooks<sup>3</sup> of obstetrics for undergraduates and practitioners of medicine. With each succeeding edition the material was changed, brought up to date and new illustrations added. Two years before his death Dr. DeLee was asked to prepare the eighth edition. Because of his untimely death Dr. Greenhill was given the job. Dr. Greenhill's selection for this labor was a fortunate and happy one. He has done a finished piece of work.

In this edition rearrangement of material was made in the first third of the book. Another outstanding change was the substitution of English terms for the Latin ones in the designation of presentation and position. Many new chapters have been added, bringing the work abreast of the times. Much of the work has been rewritten, and old illustrations have been taken out and new ones put in their place. All in all, Greenhill has fashioned a modern, up-to-the-minute work on obstetrics built on a scientific foundation that has been standard for over three decades.

Dr. Greenhill and the publishers are to be congratulated on the end results of their efforts to keep alive and to keep in the front rank a work that has been a medical household standby for so many years.

With the passing of time gynecology also has undergone changes. To have this the more forcibly brought to mind glance through a textbook on gynecology published about 1900, or one published circa 1910 or 1920. The evolution has been gradual and slow. Today gynecology is not merely a surgical art; much of it is medical and preventive. One must know how to differentiate between functional disorders and organic; he must be familiar with the more common factors of endocrinology and chemotherapy. The thing lacking in most books on this subject in the past and, for that part, over 95 per cent of present day works, is that of female urology. At best the authors pass by this important field of medicine with scant mention. Yet every gynecologist knows that familiarity with urological conditions in the female makes him more competent to handle the more serious accidents and complications in obstetric and gynecologic practice as concerns the urinary organs. Therefore, if any one feature of Dr. Wharton's work<sup>4</sup> is outstanding and causes

<sup>3</sup> *The Principles and Practice of Obstetrics*. By Joseph B. DeLee and J. P. Greenhill. 8th ed. Philadelphia, 1943. W. B. Saunders. Price \$10.00.

<sup>4</sup> *Gynecology. With a Section on Female Urology*. By Lawrence R. Wharton. Philadelphia, 1943. W. B. Saunders. Price \$10.00.



the reviewer to recommend it, it is the part devoted to gynecologic urology.

At the beginning of each chapter is an outline so the reader may see at a glance the whole subject "in its proper proportions." The work comprises 1,006 pages, 444 illustrations, a Bibliography at the end of each chapter, and an ample Index. It is a good book from every angle.

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